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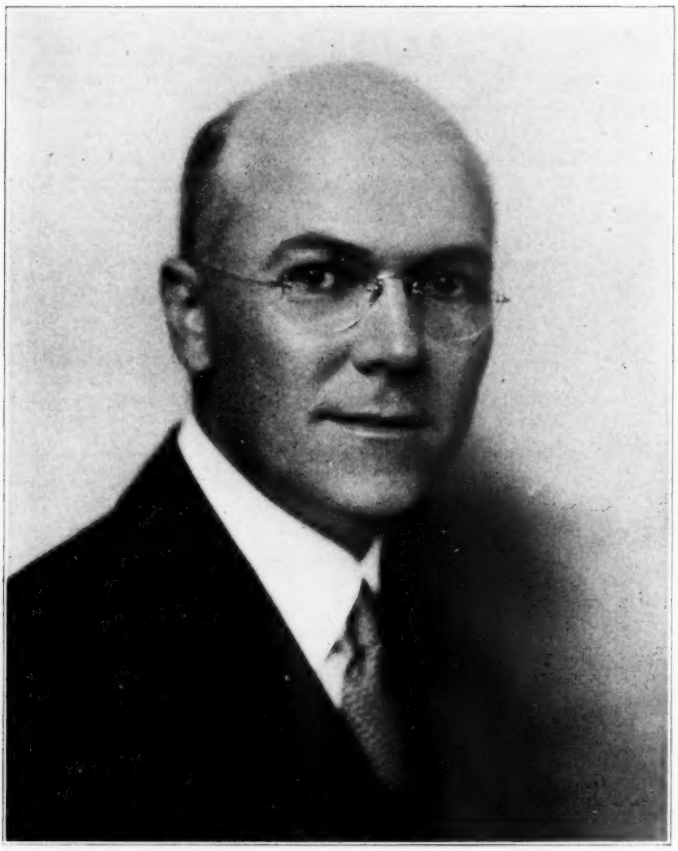

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THE JOURNAL *of the*
AMERICAN DENTAL ASSOCIATION
and THE DENTAL COSMOS

Vol. 24 AUGUST 1937 No. 8

THE HISTORICAL AND BIOLOGICAL ASPECTS OF THE PULPLESS TOOTH QUESTION

By GEORGE C. SHARP, D.D.S., Pasadena, Calif.

HISTORICAL

IN 1891, Dr. W. D. Miller first directed the attention of the medical and dental professions to the relationship between infections of the mouth and many general constitutional diseases. Little notice was given his work, however, and it remained for William Hunter, of England, to popularize the theory.

Hunter, as early as 1898, began to emphasize the importance of dental infection, introducing the term "oral sepsis" to include various types of dental infection. In 1900, he mentions pleurisy, empyema, gastritis, nephritis, pyelitis, perinephritic abscess, cholecystitis, anemia and endocarditis as not infrequently arising from dental infection through hematogenous distribution of bacteria. In 1910, in an address, at McGill University, on "The Rôle of Sepsis and Antisepsis in Medicine," he flayed American prosthetic work as haboring infection. He asserted that the gold fillings, gold caps, gold bridges, gold crowns and fixed dentures, built in, on and around diseased teeth, formed a veritable mausoleum of gold over a mass of sepsis, to which there is no parallel in the whole realm of medicine or surgery. His recommended treatment was simple antiseptic dressings of the gums and teeth to remove accumulations of débris, pus and tartar, for, in these early papers, as Dr. C. N. Johnson points out, he was concerned with the visible infection—never with infection from the apices of the roots of teeth, the conclusion to which the overhasty jumped.

Then Billings (1912) and Rosenow (1915) began their animal experiments in oral infection which, though not verified by the subsequent investigation of other scientific men, inaugurated a reign of terror for the pulpless tooth.

The filling of the root canals of pulpless teeth had by this time, however, become a fine art.

In 1757, Dr. Bourdet and, in 1809, Dr. Edward Hudson (one of the early Philadelphia dentists) practised pulp extirpation and the filling of the roots of anterior teeth to the apex with gold. Dr.

Robert Woofendale was experimenting with the treatment of the dental pulp in 1783. Various means of treatment were used by J. Foster Flagg and Leonard Koeker, about 1825, including oil of cloves, oil of cajuput, camphor, opium, alum and myrrh. In 1836, Dr. Shearjashub Spooner, in his book, "Guide to Sound Teeth," introduced arsenic for devitalizing pulps. In 1839, a warning against this drug was given by Dr. Chapin A. Harris in his book, "The Dental Art," but the warning went unheeded. John Hunter, in 1835, advocated burning the nerve as near as possible to the point of the fang, by acids and strong alkalies. Thomas Bell, who added notes to Hunter's book, said the burning should be done with a cauterizing wire at white heat.

In an article in the *American Journal of Dental Science,* Vol. 4, under the heading, "Gossip with our Profession," we learn a little about how root canals were treated years ago:

> If the nerve be not already dead in the fang, we destroy it entirely, and in all cases, plug the fang with gold, from the apex to the end of the dowel. This prevents the stagnation and horrible fetor of animal matter within the fang, and in our practice, not only prevents subsequent disease almost always, but will put an end to disease already existing in a great many cases where the common practice has been followed.

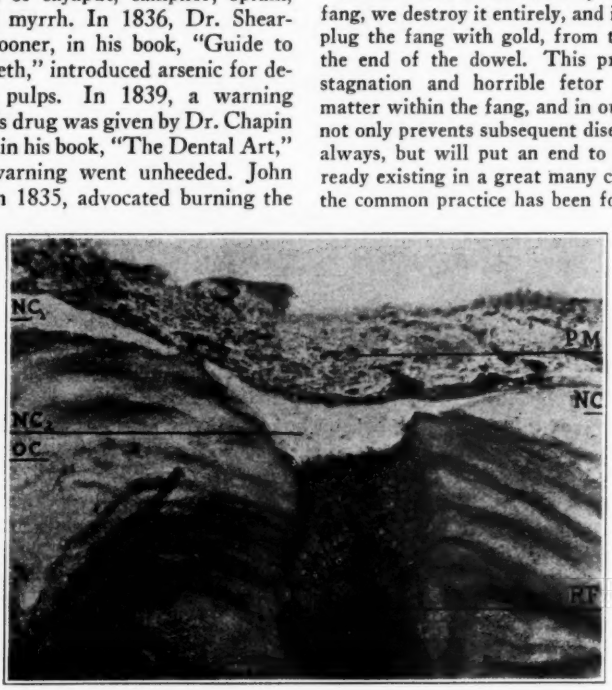
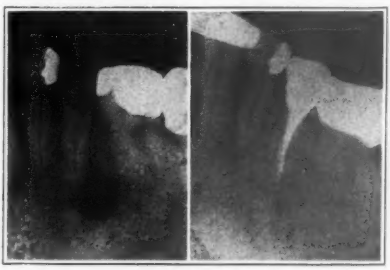


Fig. 1.—Section through the root-end of an upper molar, the canals of which were treated and filled seven years before extraction. A layer of newly built cementum completely covers the original apical cementum, as well as the end of the gutta-percha root-canal filling. RF, root-canal filling (gutta-percha); OC, original cementum at the root-end; NC_1, newly formed cementum over the old cementum on the original root surface; NC_2, newly deposited cementum completely covering the end of the root filling; PM, connective tissue of the periodontal membrane that came along during extraction of the tooth.

The practice of destroying pulps by driving a sharp stick in the canal, removing its contents and afterward using the point as a root-filling was in common use for some time, until the many fractures resulting therefrom ended the practice. An article on "Fang Filling," in the

American Journal of Dental Science, in 1856, describes a procedure common at that time. The method of procedure was to draw the temper from a fine broach and cut upon it barbs like those of a fish-hook, covering one entire side but leaving the other side perfectly smooth. With the smooth side against the side of the orifice, the instrument was thrust to the bottom of the pulp cavity to the very foramen of the root; whereupon the instrument was quickly rotated so as to bring its barbed side in contact with the pulp, and the pulp extracted from the cavity. When the cavity was further cleansed with small instruments, it was ready for filling.

Gutta-percha, which had come into use as a temporary stopping about 1847,



A B

Fig. 2, A (April 2, 1926) and B (May 25, 1936).—An unusually large rarefied area which responded very well to treatment with sodium potassium and electromedication.

proved so excellent for filling root canals that, in 1887, gutta-percha root-canal points were introduced. Tomes, in his "Dental Surgery" (1897), mentions paraffin as a root filling and speaks of excellent results attending its employment.

As early as 1873, Witzel claimed that the pulp stump became calcified after amputation. He demonstrated regeneration at the apical region of teeth, the root-ends of which had been treated and partially filled.

Creosote, creosote and arsenic, nitrate of silver and chloride of soda were used for cleaning out the canals. Dr. W. H. Trueman advocated chloride of zinc to prevent decomposition of the contents of the tubuli when filling roots. About 1890, Dr. Schreier, of Vienna, introduced sodium and potassium for the cleansing of root canals preparatory to filling and, in 1894, Dr. Callahan introduced sulfuric acid for the same purpose. Before filling the canals, Dr. Callahan lined them with chloro-resin, which method is now generally known by his name. The practice of using mummifying paste was introduced by Dr. W. D. Miller about 1893. The agent used for this purpose was mercuric chloride, but alum, thymol and formalin came into favor later.

In about 1900, the x-ray came into use in dentistry, but no one developed a technic for root-canal work guided by the roentgen-ray until, in 1911, Dr. Rhein advocated a procedure, supported by roentgenography, using Schreier's paste and employing electrolytic medication for infections of the periapical region. Some few years later, Dr. Percy R. Howe advocated the silver reduction method of treating root canals. So that, up to the time of Hunter and Billings and Rosenow and since, much definite progress has been made in perfecting the root-filling technic. The focal infection theory, however, was accepted so seriously by both the medical and dental professions that a veritable crusade against the pulpless tooth swept most dentists off their feet.

By 1920, the crusade against pulpless teeth was probably at its height. Says one editorial writer:

> From finding that the medical profession refuses to take any notice of teeth, the dental surgeon discovers that his domain has received an unwelcome and even embarrassing amount of attention. Physicians re-

garded teeth only as sources of infection and of no biologic value. Many useful and harmless teeth were needlessly sacrificed not only without benefit to the patient, but with positive detriment to masticating efficiency. Dentists who were unable, from lack of skill and practice, to properly fill root canals welcomed the easier method of extraction. To avoid criticism from the medical profession, many dentists readily subscribed to the doctrine that the teeth are responsible for all illnesses that the physician knows not how to cure. Where before, the gall bladder, the appendix, the tonsils and the ovaries of women had been in especial danger, now it was the teeth. Charles K. Mills said, "If the craze for violent removal of teeth goes on, it will come to pass that we shall have a gutless, glandless and toothless race, and that we may have, thanks to false psychology and surgery, also a witless race.

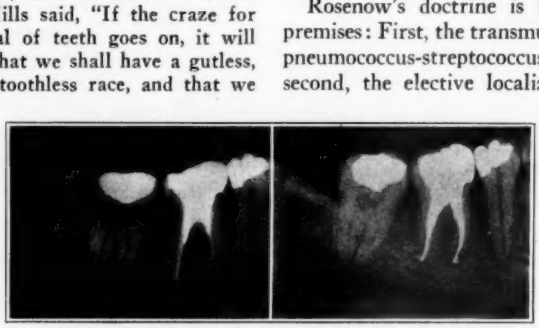
By 1930, however, scientific dental knowledge was being so developed that this radical attitude was abating somewhat and a more sane and conservative view is now being taken by both the medical and the dental profession. L. P. Anthony says:

We have turned from the destructive policy and the path of least resistance to the constructive, which, even though it is beset with more difficulties, certainly offers more possibilities of making the masticatory apparatus a useful and helpful organ rather than a crippled one and a constant menace to the welfare of the human organism.

The aim of modern science is not to mutilate but to preserve the body, and dentistry is no longer the most destructive of the sciences.

Rosenow's spectacular experiments were, by this time, being investigated by bacteriologists both in this country and abroad. Other investigators were not able to reproduce his results, and the experimental work upon which his theories are based is now criticized severely both in this country and in Europe.

Rosenow's doctrine is based on two premises: First, the transmutability of the pneumococcus-streptococcus group and, second, the elective localization of certain organisms, especially the streptococcus, in a focus.



A B

Fig. 3, A (April 21, 1925) and B (April 25, 1931).—Another case similar to case in Figure 2, A and B.

Morgenrath, of Berlin, and Nakamura, of Prague University, made a prolonged study of changing *Streptococcus hemolyticus* to *viridans,* but decided it was absolutely impossible to produce such results. Bach, of Prague University, concluded faulty conditions only could produce results. George Kudler says there is no proof of the universal pathogenicity of the *Streptococcus viridans* through the embolic route, as Rosenow claims. By "elective localization," Rosenow means that the localization of bacteria in the

body depends on inherent differences of a highly specific nature in the bacteria themselves, which they have evolved in response to their environment. He claims that bacteria, especially streptococci, from foci of infection will produce lesions in animals corresponding to those in patients from whom the microorganisms were isolated.

In 1930, Rosenow presented his theories before the forty-second annual meeting of the German Society for Internal Medicine, in Wiesbaden, in which he reached the following conclusions concerning dental procedures:

In various chronic diseases frequently all pulpless teeth of a patient have been found infected regardless of whether the radiographic findings were negative or positive; usually in these teeth streptococci could be found which in the animal experiment were able to reproduce the same disease. This proved to be the result without regard to the variety of methods employed in removing the pulp and filling the root canal. Therefore we believe the removal of pulps and filling of root canals, which is used as a routine method in America, should be discontinued. We hope that a satisfactory method will be found not only to sterilize infected pulpless teeth and periapical tissues, but also to prevent a later reinfection. This postulate must absolutely be upheld, and until it is fulfilled we believe that it is more advisable to remove infected or pulpless teeth than to retain them and run the risk that later they may become the source of a dangerous infection.

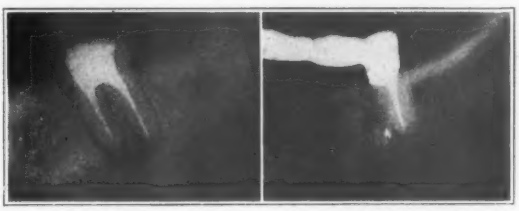
In the discussion that followed, in which prominent bacteriologists and internists took part, Rosenow's statements met with many objections.

In a paper published in Germany, E. Dickman says:

The problem of oral sepsis has made little headway in Germany as an extensive factor in the general communal health. It is thus far impossible to show exact proofs that diseased teeth can cause a multitude of remote affections.

F. Schlesinger, in 1930, writes:

It is one thing for American dentists to subscribe to the doctrine of focal infection and quite another for them to endorse wholesale extraction. In Germany this practice is almost unknown.



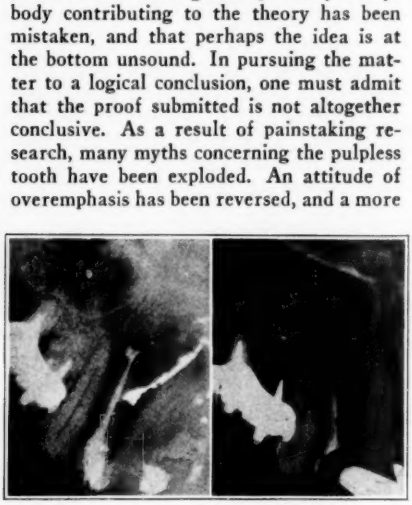
A B

Fig. 4, A (January 19, 1925) and B (May 4, 1932).—Case showing removal of the mesial root of the tooth, the distal root filled and the tooth carrying a bridge. It is still quite firm and has given the patient good service and will likely continue to do so.

Lehman, of Berlin, says the relationship between infected teeth and systemic illness has been highly overrated. Proell and Stickl, in Germany, have recently checked the theory of elective localization in seventy-one rabbits according to the method suggested by Rosenow. Only twelve of these animals died of sepsis, and in none of them could any signs of elective localization be discovered.

MacNevin and Vaughan, in their book on "Mouth Infections," published by the Joseph Purcell Memorial Institute, after abstracting all available literature, conclude:

One is impressed with the limitations of every type of evidence submitted. It leaves one with the feeling that probably everybody contributing to the theory has been mistaken, and that perhaps the idea is at the bottom unsound. In pursuing the matter to a logical conclusion, one must admit that the proof submitted is not altogether conclusive. As a result of painstaking research, many myths concerning the pulpless tooth have been exploded. An attitude of overemphasis has been reversed, and a more conservative attitude toward the pulpless tooth is everywhere apparent.



A B

Fig. 5, A (October 13, 1916) and B (March 12, 1936).—Tooth root filled for over twenty years, the patient having no reason to regret having saved it, as it will no doubt last her for many years.

THE BIOLOGICAL ASPECT

The most convincing plea for saving the pulpless tooth, however, is a consideration of the tooth itself. A thoughtful examination of a cross-section of a tooth is more revealing than any theory of infection.

The dental pulp is a soft, sensitive, highly vascular organ, which occupies the central portions of the root or roots and crown of the tooth. It is surrounded by dentin except at the most apical portion of the root, which is lined by cementum. During life, the pulp appears as a soft, pinkish, encapsulated tissue. Its two functions are the formation of dentin and the sensory function of responding to thermal change and trauma. Throughout life there is a gradual histologic change in the pulp of the tooth.

From an anatomical standpoint, it is largest at the time of eruption of the tooth, after which it begins to dwindle in size until, if remaining *in situ* at the period of senility, it occupies only a small area in the interior of the tooth. During adolescence, it furnishes inorganic matter to the dentin and provides sufficient organic nutriment for the complete development of the tooth. The formative function of the pulp has been fulfilled in teeth in the mouths of adults where thorough consolidation of the dentin has taken place. During the remainder of its life, the pulp seems to be concerned in filling the pulp cavity with secondary dentin.

We find teeth that apparently do not contain any pulp and, upon sectioning, they show complete calcification of the pulp even in teeth that are still vital. Nature often retains these teeth in their sockets, with no impairment to surrounding tissues, after the pulp has been practically obliterated by continuous building in of dentin. This leads us to believe that it matters not if the pulp is artificially obliterated, so long as the vital cementum surface remains and provided the apical foramen and the root canal are hermetically sealed so that no living bacteria can find access to the apical area around the root tip.

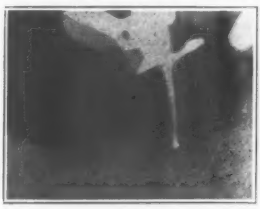
There is no direct access from the pulp canal to the pericementum in normal teeth except through the apical foramina; therefore, the relationship of the pulpless

tooth to the organism as a whole must depend upon the correct sterilization and sealing of the apical third of the root canal. Any organisms remaining are sealed between an impervious cementum on the outside and an impervious filling on the inside. As Kronfeld and Marshall have pointed out, the theory of the reinfection of filled canals has no standing, since the dentinal tubule ends are covered completely, either by filling material or by osteoid cementum in the so-called healed cases, and the wall of separation between the dentin and the cementum is impermeable to the contents of the dentinal tubuli.

John Hunter, physiologist and surgeon, in a work on the teeth published some one hundred and fifty years ago, said that the teeth most certainly had a living principle, by which means they became an integral part of the body, and were capable of uniting with any part of a living body. We know today that this vitality still remains in the tooth whether or not the pulp has been destroyed. This vitality is maintained by the cementum from the peridental membrane. This thin layer of tissue between the root of each tooth and its bony socket would have to be destroyed before the tooth would cease functioning or be classified as "dead." Just how dead a pulpless tooth is can easily be determined by attempting to remove it without the use of an anesthetic. We know that, if a tooth were really "dead," Nature would cause its removal by resorption and exfoliation as a foreign body. Gottlieb, in his biologic studies, has shown that noninfected pulpless teeth implanted in the muscle tissue of white rats give no abnormal reaction, and therefore cannot be considered as foreign bodies.

We know, furthermore, that pulpless teeth are not "dead," because the regeneration of the apical region, both within and without the apical canal, after treating and filling the pulp canals, demonstrates that they have not yet lost their vital attachment and relationship to the investing tissues and to the body. The periodontal membrane is similar to ligamentous structures in joints, in that it is composed of white, fibrous connective tissue and is essentially a supporting structure, but, in addition, it has nutritive and formative functions and is in some degree analogous to the periosteum of bone. The formative function is important, since the power of laying down and resorbing calcified tissue exists throughout life. Micro-

A

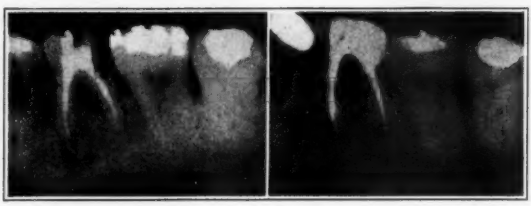


B

Fig. 6, A (August 17, 1930) and B (March 22, 1936).—A case of abscess in the right lower bicuspid, in which the canal was cleansed thoroughly with sodium potassium; treated by electrosterilization, using normal salt solution and pure zinc point, and later filled. Last x-ray taken in 1934, showing it practically restored to a normal condition.

scopic examination of teeth with properly filled root canals will show new formation of cementum on the apical end of a tooth root without a pulp in the same way as this occurs in a tooth with a vital pulp all during life. First, there will appear a connective-tissue scar over the root-end, then regeneration of the apical periodontal fibers and, finally, the deposition of new cementum over the root filling material and the apex. Published reports of cases have been presented by Blayney, Boulger, Coolidge, Davis, Grove, Hatton, Kronfeld, Skillen and others.

Repair of tissue occurs in the following stages: Inflammatory resorption of both soft and hard tissue, replacement of inflammatory tissue by fibrous tissue and repair of resorbed area in root and bone



A B

Fig. 7, A (August 8, 1925) and B (October 17, 1935).—A peculiarly shaped mesial root in another case, which was treated in the same manner as that in Figure 6, A and B.

by a cementoid tissue and bone. Blayney and Kronfeld say that, in many cases, if teeth that have an area of resorption to begin with are treated, it has been found clinically that the area around the root-end disappears.

Since the pulpless tooth possesses this system of repair, it is unwarranted to order its extraction merely on suspicion. The finding of bacteria is insufficient evidence for extraction, since we know that not all bacteria are actively causing infection. Furthermore, the theory of potential infection at some time in the future is absurd, for every organ in the body is likewise a potential source of infection. Anthony Bassler says the intestinal canal is the most important source of focal infection in the body; one hundred and sixty-two different organisms have been identified in the human intestinal canal, whereas about ninety are to be found in the mouth. If infection is found in the mouth, it must be eradicated, but instead of immediate extraction, effort should first be made to obliterate the infection by sterilization and root filling. Such treatment will preserve the organs of digestion as nearly intact as possible.

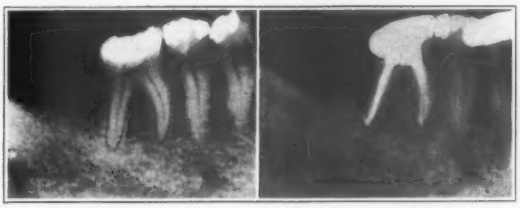
Since it is not only pulpless teeth, but also vital degenerating pulps which have been associated with systemic disturbances, it is necessary to prove which tooth is actually the cause of disturbance, else there is no limit to the extent of extraction. John G. Kuhns, of Peter Brigham Hospital for Chronic Diseases, Boston, makes the astonishing statement that almost one-half the patients admitted to that hospital over a period of ten years were edentulous. These patients were definitely handicapped by loss of the teeth, as they were deprived of the principal aid to recovery in having the nutritional mechanism so crippled that they could not receive proper nourishment. Removal and long absence of teeth aggravate the lowered resistance of patients. The teeth should be considered as an important fac-

tor in recovery from chronic disease rather than the main etiologic instigator of all the ills to which humanity is heir.

TECHNIC OF ROOT FILLING

The technic for treating and filling root canals has become so simplified with modern equipment that the average dentist can easily perform the operation if he is but willing to use care and asepsis. He must, of course, understand the shape, position and size of the pulp chamber and the number of canals. The pulp chamber should be opened so that no overhanging dentin is left at any point in its periphery. Dentin and enamel should be cut away wherever these are found to present interference to an approach to the canal in line with its lumen. The canal itself should nearly always be enlarged to an appreciable degree, especially if constricted through natural form or through deposition of secondary dentin. This enlargement, which should produce a lumen nearly circular in cross-section, facilitates treatment and subsequent fillings and clears away tiny irregularities which hinder proper cleansing and filling.

An antiseptic must be sealed over an exposure prior to the removal of the pulp, to prevent subsequent periapical tissue change through the entrance of other organisms. The pulp tissue should be anesthetized by conduction or infiltration anesthesia, and not destroyed by arsenic. All the pulp tissue should be removed without undue injury to the fibrous tissue normally found in the ramifications of the canals. We know that healing of small portions of pulp tissue remaining in the pulp canals does occur, but when large portions of pulp tissue are left, they disintegrate, and infection follows. Care must be taken that no débris is forced through the apex. I use Rhein's method of working Schreier's paste through the apex to clear the canal and then flooding it with mercuric chloride in Marchand's peroxide. I seal the latter in the tooth while maintaining drainage for several treatments, if necessary. I always seal a diagnostic wire in the canal to see that the apex has been penetrated in infected teeth.



A B

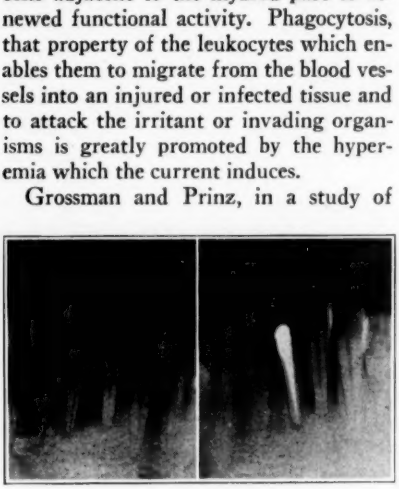
Fig. 8, A (April 14, 1930) and B (December 16, 1935).—A more or less doubtful case for treatment, but one that responded remarkably well, and appears to be perfectly safe in the mouth.

ELECTROSTERILIZATION

I find electrosterilization the easiest and most successful method of root-canal sterilization. Electrosterilization is based upon scientific principles, is practically painless, requires fewer sittings than other methods, gives no unpleasant after-effects and obviates such extensive operative procedures as curettement and root amputation. By this method, the dangers of irritating or tissue-destroying drugs and instrumentation beyond the apex may be avoided. The vitality of the tissues is retained to assist in healing. Herman

Gruher says the electric current has a tendency to lessen the edema and congestion and simultaneously diminishes the accompanying symptoms of swelling and pain. In chronic inflammatory conditions the current tends to stimulate sluggish circulation and arouses the dormant cells adjacent to the injured part to renewed functional activity. Phagocytosis, that property of the leukocytes which enables them to migrate from the blood vessels into an injured or infected tissue and to attack the irritant or invading organisms is greatly promoted by the hyperemia which the current induces.

Grossman and Prinz, in a study of



A B

Fig. 9, A (February 8, 1932) and B (January 4, 1933).—Case in which the dentist intended extracting the two central incisors. Because of the author's decision that the left central was the only one in question, it was filled, with the result shown.

sixty cases, show that electrosterilization is more effective than sealing in a medicament, such as chlorphenol, in the root canal. The index of efficiency was the number of treatments required in each case to obtain a negative culture. The ratio between the group treated with electrosterilization and the other group treated with camphorated chlorphenol was 1:2. The treatment period was shorter when electrosterilization was used in a ratio of 2:3. Prinz concludes that electrosterilization brings the question of proper canal sterilization within the realm of mathematical precision.

The apparatus for electrosterilization is quite inexpensive and requires no great knowledge of electricity to operate. The direct current must be controlled by a rheostat, and the milliampere meter of the apparatus should register the exact current strength within the tissues.

I have used the following method, originated by M. L. Rhein, for a period of over twenty years, with a high percentage of successes:

After the canal and apical area have been drained and irrigated until free of all débris and suppurative exudate, the pure zinc-wire electrode is adjusted into the root canal as near to the apex as possible. Owing to greater antibacterial effect, the evolution of less gas, the lower irritability produced in the tissues and the attraction which the anode has for bacteria, the positive pole appears to be far superior to the negative. The negative pole is enmeshed in a piece of wire covered by a wet sponge and placed on the cheek under the rubber-dam holder. No part of the patient's body should touch any metal, and the touching of neighboring metallic fillings in teeth should be avoided. The current is started from zero of the volt register and gradually raised until the milliampere meter on the face of the apparatus registers one or one and one-half milliamperes. When the patient feels a tingling sensation, the current strength is diminished slightly so that the tooth feels entirely comfortable. From time to time the electrolyte in the root canal is replenished. The electrolytic action is maintained from fifteen minutes to as long as one-half hour, depending on the extent of the diseased tissue to be eradicated. The operator soon learns to judge the necessary amount of time for steriliza-

tion. The current is turned off before removing the electrode.

In multi-rooted teeth, each root canal is treated separately. The electrolyte is sealed into the tooth between treatments, and should be renewed preferably every forty-eight hours. The number of treatments necessary is decided by culture for sterility. It is interesting to note that after electrolytic treatment and the sealing of the saline solution in the canal, the tooth may be left without further treatment for as long a period as a year before filling, with no harmful results, and a perfect healing will occur.

I use normal salt solution for an electrolyte. I have found this adequate, for all teeth treated, to destroy bacteria over a considerable area and yet cause no tissue destruction. Pollia says chemical atrophy will cause the disintegration of bone after powerful medicinal agents are used in the root canal. I have found the use of iodine and other drugs for electrosterilization unnecessary and undesirable because of danger of tissue injury.

With electrosterilization carefully carried out, infection is eliminated and regeneration of normal tissue occurs. Pulp-canal therapy demands a surgically clean technic but, as in surgery of any other part of the body, not a bacteria-less procedure. Ideal sterility is not essential if the main mass of organisms is eliminated; the white corpuscles are easily able to prevent any damage from a very small number of bacteria remaining. The surgeon knows that the body is capable of coping with a certain number of bacteria. From any of the gunshot wounds suffered by the soldiers of the World War, positive cultures could be obtained at any time; yet the wounds healed and the men became perfectly healthy.

In making a culture, bacteria can only be picked up by a pulp-canal instrument, by aspiration or by placing in the canal an absorbent point saturated with culture medium. Alfred Walker says these procedures are subject to a high degree of error; the test may be negative even when living organisms are present. Since we are not able to recover all organisms present, the results are at best uncertain.

Though some operators have been experimenting with underfilling of canals, the concensus of opinion still favors filling to the apex, in uninfected cases, with a dense and well-adapted filling. I present roentgenograms of cases of my own where satisfactory healing has remained after a period of years, by filling to the apex or through it in infected cases.

Gutta-percha is well tolerated by the body. It heals in without any inflammatory reaction and is completely covered over by both hard and soft tissue, and is completely healed in between layers of newly formed cementum. It is indifferent and sterile toward the tissues and capable of bringing about an artificial closing of the root canal after the soft tissues of the root canal have been extirpated. The filling material applied directly to the wound helps to reduce the traumatic inflammatory symptoms, after which a change from granulation tissue into connective tissue gradually sets in, and a healing of the foreign body into the soft tissues is effected.

In filling the canal, we strive to fill the dentinal tubules, as well as the foramen; so that an impermeable cohesive material which will displace moisture in the canal and will not leak must be used. Thus reinfection of the root canal cannot occur because of complete closure. Blayney, Coolidge, Davis, Hatton, Kronfeld, Rickert and Moen have shown the healing in of gutta-percha in pulp-canal filling. Boulger reports, in examining teeth with filled roots, that the connective tissue was closely adapted, and cementum was de-

posited upon the gutta-percha in the absence of infection.

I present a photomicrograph of a case of my own which Kronfeld has previously reported. (Fig. 3.) The tooth, after being filled for seven years, was extracted at the order of a physician, with the consent of the patient, supposedly as a cure for arthritis. Kronfeld states: "The tooth was clinically and radiographically normal. In the specimen, the root-canal filling (gutta-percha) can be seen very closely adapted to the wall of the root canal, with the filling ends almost level with the root end. The surface of the root, as well as the surface of the gutta-percha point, is covered over by a continuous layer of young, vital cementum. Part of the periodontal membrane that came along during extraction is attached on the outside of this layer of cementum; this tissue is entirely free from inflammation. The most remarkable fact about this specimen is the direct contact between a foreign substance (gutta-percha) and a vital tissue (cementum); the cementum has been deposited directly upon the surface of the filling material."

It is not the pulpless tooth that we have to fear today as endangering the health of our patients, for twentieth century dental science is adequately able to cope with pulpless teeth. It is the untreated, degenerating vital pulp which is a source of danger to the system. Dentists who leave diseased dentin for fear of exposing the pulp are shirking their responsibility. A patient with a properly treated pulpless tooth, checked annually with radiograms, can suffer no ill effects from the tooth. He will be able to masticate his food thoroughly and in comfort. His appearance and enunciation will be normal. If we are to be worthy of our calling we should study and practise to perfect ourselves in this operation which is so highly desirable for the happiness and well-being of our patients.

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DENTAL CARIES AND THE ORTHODONTIC PATIENT

By HAROLD J. NOYES, B.S., D.D.S., M.D., Chicago, Ill.

THERE appears to be increasing concern in the minds of the laity, and of the profession as well, with respect to the etiologic significance of orthodontic appliances in dental caries. A frequent question is, "Will appliances cause cavities?" Many parents recount instances in which, on removal of appliances, numerous and extensive dental restorations were necessary.

The orthodontist has taken the question rather lightly because, in his experience, the extent of dental caries following treatment is tempered by the number of cases in which there is no evidence of the disease and, further, because his attention is centered on his own field, wherein his concentration tends to obscure this very important and disturbing feature. On the other hand, both parents and dentist are intimately concerned with the extent of dental caries. When cavities occur in treatment, the most obvious feature of the mouth is the appliance of the orthodontist. It is not surprising, therefore, that superficial reasoning would suggest that the orthodontic appliance is the cause of the condition. It is the simplest explanation. Our present incomplete knowledge of the cause of caries is difficult to explain to the layman, and perhaps it is for this reason that many dentists adopt the line of least resistance and, when the question arises, either concur or suggest that the mechanical appliance is responsible. It has been an easy and effective method of disposing of an annoying question.

This apparently innocuous situation in which the orthodontist avoids a problem the patient has repeatedly placed on his doorstep has grown until practically every person who contemplates orthodontic treatment becomes informed, in more or less terrifying proportions, of this hazard. Because of the seriousness of the problem, and the failure of the literature to supply any very satisfactory data on it, a careful analysis of the incidence of dental caries in 100 orthodontic patients, all of whom received treatment, was thought to be of value in throwing some light on the question.

The cases in this series, which are all

(Read before the Section on Orthodontia at the Seventy-Second Annual Midwinter Clinic of the Chicago Dental Society, February 18, 1936.)

from private practice, comprise the group for which the medical background has already been reported.[1] They were chosen at random by an office assistant, without respect to any factors other than that they included a sufficient period of observation and treatment to justify the tabulation of statistics. They were treated by either Dr. Allan G. Brodie or Dr. Frederick B. Noyes or by me, and the appliances used were either the ribbon or the edgewise arch. The first molars, whenever present, were banded without exception, as were the incisors, and in cases treated with the edgewise arch, the bicuspids, or deciduous molars, usually carried formed soldered bands of gold-platinum alloy. The group was about evenly divided with respect to sex, there being forty-eight boys and fifty-two girls. A tabulation of the height and weight of these patients shows them to be well above the average in these respects, and, similarly, the instance of acute and of chronic infection, as well as systemic disease, is far below that of the average child. The patients come, as a rule, from homes which place them in the class known as "privileged children." This, of course, has an important bearing on the incidence of dental caries. For the same reason, the data have greater significance from the point of view of the private practitioner of orthodontia than if they represented the statistics of a clinic or dispensary group. It is, however, extremely difficult to obtain satisfactory, comparable records for use as a control.

In this series, a cavity or carious lesion is considered to be a carious disintegration or solution of the calcified tissues of a tooth as demonstrated by roentgenographic evidence. No differentiation is made between treated or restored cavities and untreated lesions. Full-mouth roentgenograms were taken as the criterion for uniformity. There were 383 full mouth roentgenograms in the series. It is recognized that, in a particular examination, there may be early carious lesions not discernible in the roentgenogram. The fact that the observation is not limited to a single set of films, but extends over an interval in which repeated roentgenographic records were made, supports the choice of the method, as does the fact that it furnishes data which were subjected to analysis in retrospect.

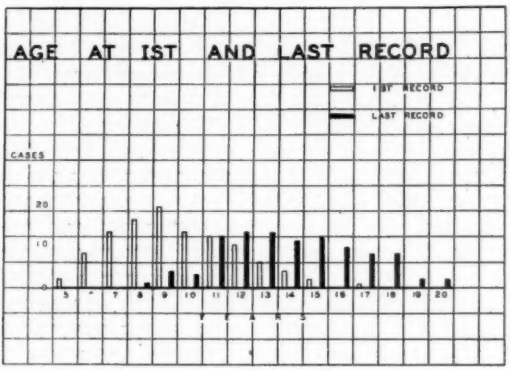

Fig. 1.

There is no absolutely satisfactory criterion for clinically differentiating the carious lesion. Oral observation in doubtful cases varies with the observer. On the whole, and in the light of the conditions encountered in this investigation, the procedure employed was considered to be the more accurate. It was used in all cases to permit comparison. The figures given in this paper should be considered relative rather than absolute.

The comparison with other studies is obstructed by the manner in which statistics have been gathered by diverse investigators. In some instances, the number of cavities per erupted tooth is reported; in others, only the teeth of adults are taken into consideration. In practically all of the studies reviewed, there were either local environmental conditions or matters of technic in recording which prevented their use as a satisfactory control to this series. It should be mentioned in passing that all attempts to correlate this with other groups indicated less caries in both the "before" and the "after" patients of this series. This may be expected in consideration of their age and environment, as well as because of the method. The age of patients at first observation ranged from four to seventeen years, with most in the years fourteen to sixteen.

An analysis of the age before and after treatment reveals that between the ages of eight and fifteen, first and last observations overlapped with respect to particular ages and groups. (Fig. 1.) This offered an opportunity to check the occurrence of dental caries in patients of the same age. There is a preponderance of younger children in the "before" group and, conversely, of older children in the "after" group. For this reason, the average number of cavities per child, per age, was used. Figure 2 shows a summary of these statistics. There were eighty-three children between the ages of eight and fifteen whose roentgenograms were examined before treatment was instituted; and in this group, there was an average of 2.65 cavities per child. Of the cases examined after treatment, there were seventy, with an average of 3.75 cavities per child. These figures may indicate that there is a difference of approximately one cavity per child before and after treatment. The average period of

AVERAGE CARIES PER PATIENT
BEFORE AND AFTER MANAGEMENT

SUMMARY OF AGES 8 TO 15

CASES	FIRST MOLARS	SECOND MOLARS	ALL BICUSPIDS	ALL INCISORS	AXIAL SURFACE	TOTAL CARIES	
83	1.88	0.15	0.16	0.36	0.31	2.85	BEFORE
70	1.94	0.46	0.23	0.19	0.70	3.73	AFTER

8-11 YRS	12-15 YRS	
60	23	BEFORE
20	50	AFTER

AVE. INTERVAL BETWEEN BEFORE AND AFTER 3.8 YRS

Fig. 2.

observation was 3.8 years, which might be taken to mean that there is a hazard of approximately one-fourth of a cavity per year of orthodontic management. It should be remembered that sixty of the "before" cases fell in years eight to eleven, while there were only twenty of the "after," and between the years of twelve to fifteen, there were twenty-three "before" and fifty "after." While averages were used, this does not entirely reconcile the greater predominance of caries in later years. It is also significant that there was a very close similarity in the instances of caries in the particular teeth. For instance, there is only a very slight increase in the number of cavities in the first permanent molars, while the bicuspids in the "after" patients show a higher percentage of increase. The second molars show a higher increase as well. This is undoubtedly due, as may be the case with the bicuspids, to the fact that there are more second molars, as there are more bicuspids, in the later years. The incidence of caries in the incisors, practically all of which carried bands, was no higher in the "after" patients than in the "before"; nor was there an increase in the proportion of cavities appearing on axial surfaces.

Many of the roentgenograms used for observation were taken at dates that correspond with periods of observation, active treatment and retention. In these cases, a roentgenogram was taken at the time treatment was instituted; a second, at the time appliances were removed; a third, at the time retention was removed, and a fourth, at the time a second period of treatment was undertaken.

Figure 3, a tabulation of these particular periods, may give some idea of the relative incidence of dental caries in intervals of orthodontic management. In this table, we note that during 1,300 months of observation, there occurred sixty-seven cavities. This is equivalent to 102.3 years, or an average of 0.62 cavities per year of observation. (No appliances were worn in periods designated as observation.) During active treatment and retention, orthodontic devices are carried in the mouth. The combined totals of these two intervals is 1,392 months, during which time eighty cavities developed, or an average of 0.68 cavities per year. These figures probably more accurately

RELATIVE INCIDENCE OF CARIES IN MANAGEMENT

PERIOD	TOTAL CAVITIES	TOTAL MONTHS	TOTAL YEARS	AVE. CAVITY PER YR
OBSERVATION	67	1300	108.3	0.62
ACTIVE AND RETENTION	80	1392	116.0	0.68

Fig. 3.

represent the hazard of wearing orthodontic appliances.

Individual susceptibility of the patient must not be overlooked. The experienced clinician views with dismay a mouth presenting numerous carious lesions. He knows that these are the cases in which, in spite of his most earnest efforts, cavities will occur in the course of treatment, and, similarly, he enjoys a feeling of relief when placing appliances on teeth in mouths that are apparently immune. A statistical analysis of the incidence of dental caries during management, analyzed from the standpoint of the number of carious lesions present at the beginning of treatment, bears out this observation. In the patients who had no cavities at the time of first observation, of whom there were twenty-nine, there was an average increase of two and nine-tenths cavities per child; and in this group, there were sixteen, *i.e.,* 55.1 per cent who continued to be immune throughout the period of management. (Fig. 4.) In the group that had from one to five cavities at first observation, which included forty-eight patients, there was an average incidence during management of four and nine-tenths cavities per child, and there were but eleven remaining caries-free; or less than 25 per cent. Of the patients who had from six to ten cavities before treatment, there was an average of four and three-tenths cavities per child, and only one of the thirteen had no caries during the interval. In the eight children that had from eleven to fifteen cavities, there developed an average of 6.7 lesions. In the number that had twenty or more, the average was 7.0. While occasionally conditions arise in which an acute susceptibility develops, we may expect, in general, that the incidence will be approximately the same as that experienced before undertaking orthodontic treatment. (Fig. 5.) One notable exception to this rule is the higher frequency of dental caries in the preadolescence period.

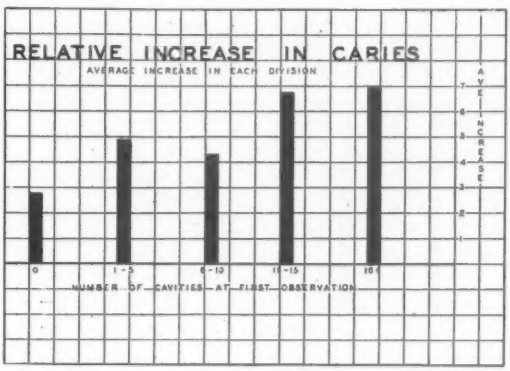

Fig. 4.

Practically all investigations of the age incidence in dental caries point to certain periods of increased susceptibility. While the technical manner in which the data are recorded by the several investigators leads to different proportions in the statistical material, there is a very significant relative similarity. There is a rapid rise in the number of cavities at about the age

of from six to seven years, and again at from nine to ten years, and, most uniform of all, the rise which occurs in the early period of adolescence. This latter interval is more significant when viewed in individual cases, as the exact age at which puberty occurs in different persons, and in the two sexes, has a tendency to level the curve when large numbers of children are considered.

The incidence of caries in Chicago public school children of from four to ten years[2] denotes a similar condition, and again the statistics on the children at Mooseheart, Ill., in the group reported

undertaking a period of orthodontic treatment that embraces these dangerous years, that there is a greater possibility of having an increase in the number of cavities than would be expected if the treatment were undertaken either a few years earlier or later. This observation, of course, refers to general averages, and we must not expect that it will obtain for every child. It is impossible in many instances, and certainly frequently inadvisable, to orient orthodontic treatment from the standpoint of the chronologic incidence of dental caries; but knowing this trend, it may be possible to exercise

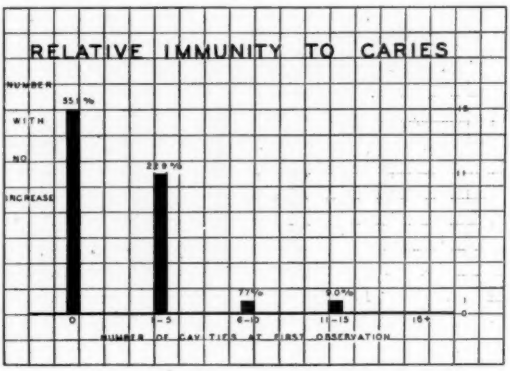

Fig. 5.

by Hanke[3] before the institution of dietary changes, reveal a similar condition in ages from ten to sixteen. The figures presented by Munblatt[4] analyzing conditions found in four groups of institutionalized children ranging in ages from four to twelve years show a similar rise, with the peaks occurring approximately a year ahead of the figures in this series. An analysis of the curve in the patients after receiving orthodontic treatment reveals similar characteristics.

It is therefore well to remember, when

greater care and more vigilant observation at these times, and also to give a word of caution and warning before undertaking treatment so that the parent, and the dentist as well, may be on the lookout. Caution of this sort is frequently of material assistance in avoiding censure, which might otherwise fall on the shoulders of the orthodontist.

Without needless repetition of individual examples of the rises of each one of these periods, a few typical graphs showing the increased susceptibility in adolescence may be of interest. Figure 6

represents cases of both sexes taken from this series which illustrate an increased number of cavities occurring during the ages from thirteen to sixteen. It is my impression, though I am unable to verify it from the statistical material at hand, that this is more marked in girls than in boys. I believe that the susceptibility of the individual has some relation to the rapidity with which the change is experienced and to the demand placed on the individual either for growth or for adjustment. I have often seen girls previously immune to dental caries develop lesions simultaneously with or slightly

general susceptibility to caries, we must expect the carious lesions to bear some relation to the teeth which carry appliances.

If this contention is true, we would anticipate seeing some difference in the curve of charts that represent relative caries in different teeth in the mouth. I have, therefore, charted (Fig. 7) the number of cavities in the various permanent teeth following orthodontic treatment. To the right of this center graph is a chart prepared from the figures of Rufus W. Leigh, captain in the Dental Corps of the United States Army, ob-

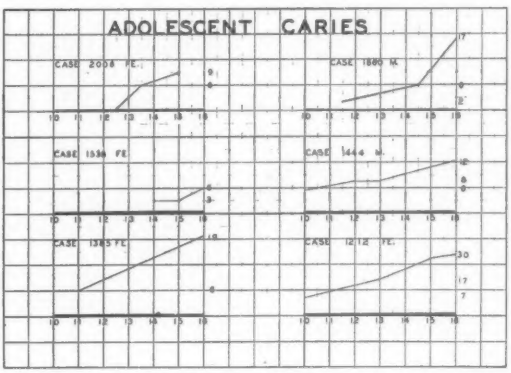

Fig. 6.—Graph of individual patients showing number of cavities and restorations in period of adolescence. The numerals along the ordinate represent carious lesions and along the abscissa represent years.

before the onset of menstruation. Similarly, the rapid increase in height which frequently precedes puberty in boys is often attended by the development of new cavities.

Another interesting comparison may be drawn between the teeth and particular tooth surfaces which are affected in this series and those reported in other investigations. Unless we assume that the placing of orthodontic appliances creates a condition in the mouth which results in a

tained from the examination of 7,942 young men from seventeen to twenty-four years old, the average being eighteen.[5] On the left is a graphic representation of the data reported by Joseph T. Cohen for ninety-nine children, aged fifteen, the majority of which were boys, and in the dotted line, on this graph, figures for ninety-eight boys at the age of eleven.[6]

The very marked similarity in the curves of all figures will be noted, there being perhaps a slightly lower incidence

of dental caries in the group of orthodontic patients in the region of the bicuspids and incisors. This is probably due to the older-age group in the case of Dr. Leigh, and the fifteen-year-old children in Dr. Cohen's group. The similarity in these graphs would indicate that the placing of bands on molars, incisors and bicuspids does not apparently alter the general picture of the incidence of caries.

From these data, therefore, it would appear that the typical carious lesions need not be appreciably more frequent in patients that have undergone orthodontic management than in the untreated child.

at the end of treatment is distinguishable as a questionable area in the roentgen-ray picture made before the placing of appliances. Finally in evaluating this material, it must be remembered that these data refer only to the typical carious lesions requiring a dental restoration and not to the condition of etching or discoloration of the enamel.

Let us now consider a matter which deserves particular attention and is of no small importance; namely, the disfigurement of the tooth due to etching. A more detailed study of the bacteriology as well as the gross and microscopic changes in

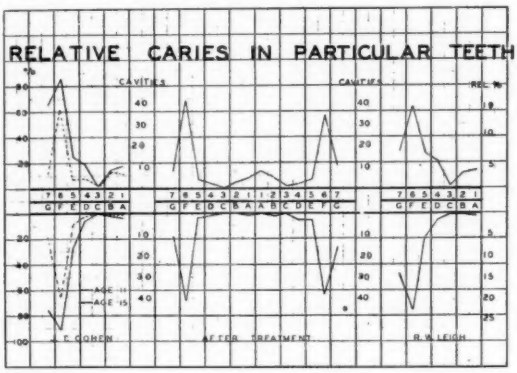

Fig. 7.

It does not indicate that an appliance which is carelessly handled will not produce the lesions, and in spite of the utmost vigilance and care on the part of the skilled practitioner of orthodontia, cavities will occasionally occur. Roentgenograms taken before the placing and after the removal of the appliances are extremely valuable, particularly from the standpoint of apprehending lesions which might otherwise go unnoticed. In the series of roentgen-ray pictures herein reported, there are several instances in which a carious lesion that is recorded

the enamel will be necessary before we can determine whether this process, when produced by appliances, is identical to the early stages of dental caries. Certain of these lesions appear to be similar to initial caries on smooth surfaces, particularly that occurring beneath accumulations of food débris. I refer especially to the etchings found on the buccal and distobuccal surfaces of the last upper molar tooth. We sometimes find conditions of this sort on the labial surfaces of the incisors, or near the gingivae on the buccal surfaces of the bicuspids.

There are certain elements that are unlike our findings in dental caries. Etching may occur in mouths in which, as far as we can determine, the carious process at the time is inactive. At present, the preponderance of evidence would suggest that the process in etching which occurs beneath an orthodontic band or about a ligature is similar, if not identical, to the process of dental caries and differs only in that the opportunity for the growth of organisms producing the acid is supplied by the orthodontic mechanism rather than some biologic or mechanical factor which permits the lodging and protection of these bacteria.

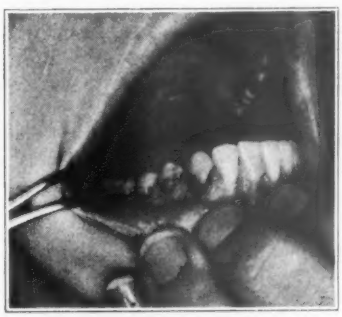

Fig. 8.—Example of gingival caries. The areas have been treated with silver nitrate.

An excellent example of etching which occurred on the gingival portions of cuspid, bicuspid and molar teeth in a girl extremely susceptible to dental caries is furnished in Figure 8. The lesions are accentuated by treatment with silver nitrate. In patients who suffer from this type of caries, we frequently find that the tooth surface protected by a properly cemented band is non-carious and the lesions are sharply demarcated above or below the margin of the band.

In this connection, it is important to differentiate between the white spots of enamel and other areas of hypoplasia and an etching. Unless hypoplastic areas are carefully noted before the placing of appliances, there may be some difficulty in convincing the parent or patient that the lesion was not produced by the appliance. There is, of course, a distinct difference in the gross appearance. A hypoplastic lesion of this character is usually an ovoid spot of milk-white enamel, the surface of which is smooth and glassy, offering no resistance to the explorer, while the etched area is less regular in its peripheral outline, has a chalkier appearance and feels rough to the point of a fine explorer. While these differences are apparent to one with dental training, they are frequently less evident to the laity.

This presentation is not designed to justify caries caused by orthodontic appliances, or to minimize its danger. While much of the evidence offered from an analysis of these cases indicates that the patients in this series were only slightly, if any, more affected by caries than those not undergoing orthodontic treatment, every orthodontist of experience realizes that there are occasionally carious lesions and, more frequently, etching, due without question to the presence of his appliances. They occur in direct proportion to: (a) susceptibility to dental caries; (b) the skill and care in the construction and use of the orthodontic mechanisms, and (c) the care of the patient in exercising hygienic measures.

While we are interested in records of the incidence of carious lesions and the study of the method of their production, our primary object is prevention. It is worth while, therefore, to consider certain prophylactic measures that may have practical application in orthodontic management. We may divide the hazard of orthodontic appliances as regards dental caries as follows: (a) that which is purely psychologic, existing only in the mind of

the parent or the patient, but which will be found to be a real condition to the patient and must be attacked as such; (b) the actual hazard of the orthodontic appliance, and (c) the general nutritional and systemic factors.

Considering these divisions separately, that of the imagined hazards from orthodontic appliances suggests two methods of attack: one general, or social, the other personal, or individual.

In the former, a more accurate and intelligent conception of the process of dental caries will be of assistance. It will be some time before the popular impression in the minds of the average dentist and layman can be replaced by a reasonable explanation and correlation of causes of the disease and its possible actual etiology in orthodontic factors. It is hoped that statistics such as are presented in the early portions of this paper may be of some assistance in this connection. When we realize that between 60 and 70 per cent of all children suffer from carious lesions during the ages in which orthodontic treatment is common, it will be evident that approximately the same percentage of orthodontic patients will have dental caries. Further, if we remember the periods of increase in dental cavities, such as that pointed out at about the age of six, again at from nine to ten, and more marked perhaps in the period of adolescence, and realize that these periods coincide chronologically with those that are of particular advantage to the orthodontist in the correction of malocclusion, it is evident that there will appear to be a correlation which in reality is merely coexistence.

From the personal or individual standpoint, it will be found that in dealing with cases in clinic and private practice, a careful outline of these difficulties before undertaking treatment is of advantage. A few moments spent in simple non-technical explanation of these conditions to parents will eliminate much unpleasant discussion at a later time when any elucidation is received with suspicion.

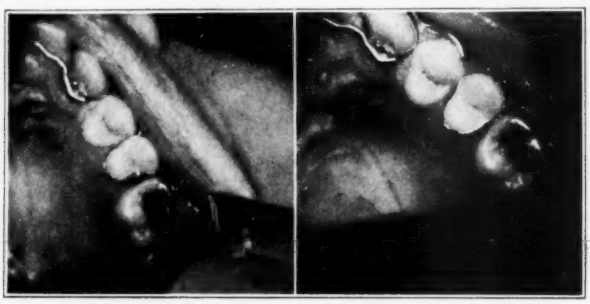

Fig. 9.—Left: Upper second bicuspid band folded over distal marginal ridge of tooth. In the stress of mastication, the cement is often lost from beneath the lapped portion of the band. Right: Bicuspid band placed without this hazard.

There is, as well, the real hazard from orthodontic appliances; and this should not be minimized, however fallacious the imagined dangers may appear. Practically every orthodontic appliance requires the placing of bands on certain teeth. This procedure, if skilfully done, with a well-formed band and adequate cementation, does not damage the tooth, and has been

shown, in the case of rampant caries, to be an actual protection to the enamel surface; but with the breaking of the seal of the cement or its washing from the margin of the band, there is produced immediately a hazard which may develop an ugly lesion to be carried through life. It is therefore important that bands be carefully made, accurately adapted and adequately cemented. They must be tested from time to time to be certain that they are in good order. It is not, in my opinion, necessary to remove bands at frequent intervals if the technic in their placement is properly carried out. There is equal danger in the recementing of each band. The lapping of the band over the proximal marginal ridge of the molar or bicuspid teeth is a decided hazard, for the cement beneath this lapped area of the band is frequently washed away, an ideal opportunity being thus afforded for the lodgment of a bacterial nidus, which may produce etching or, if long continued, an actual cavity. Figure 9, left, offers an example of such a formed band. This is often seen in the second bicuspid teeth, and is more frequent when the band must be placed on a tooth so positioned that complete seating of the crown is difficult. The obtaining of separation will be found of particular advantage in the placing of bands, and, in some instances, it is worth while to remove and recement the band when the tooth has been brought more nearly into its proper axial and occlusal position. (Fig. 9, right.)

Disfiguring lesions have frequently been produced by long continued wearing of ligatures or by the use of a finger spring or spur, as in retaining rotations. The clasp on retainers and in the areas of abutment of the cast or vulcanite plate and of space maintainers is also frequently at fault.

Mention has previously been made of the importance of oral hygienic procedures. We are all aware that in the mouths of immune persons, the accumulation of débris apparently has no effect, but in the 60 to 70 per cent of patients who are not immune to dental caries, careful attention to mouth hygiene is a very important factor in the reduction of etchings on the smooth surfaces. A toothbrush drill at the beginning of orthodontic management, the use of a suitable toothbrush, frequent prophylactic attention with the aid of a mechanically driven brush and the constant vigilance of the operator are of the utmost importance in maintaining this phase of preventive procedure. It will be found to be of practical value to record the hygienic condition of the mouth at each visit. Commendation when merit is deserved is of much value and the cooperation of parents and dentist cannot be underestimated. The parent relies on the orthodontist to be on the alert to discover both new carious lesions and conditions which favor their initiation. If he is remiss in this respect, he will justly receive their censure. The average layman makes no finely drawn distinction between operative and orthodontic dental procedures, and it is difficult to explain, after the development of a large cavity during orthodontic management, why it was not foreseen.

We come finally to a more general but particularly important division of prophylactic treatment; that is, the nutritional and systemic condition of the child. As long as we can keep the patient immune, the problem of caries in orthodontic management is practically eliminated. It is, therefore, of primary importance to obtain and maintain this state. Perhaps no other single factor in the studies on dental caries has been more definitely brought out than that the teeth of healthy children do not decay with the same rapidity as those of children who are malnourished or suffering from a chronic

systemic disease. It is therefore encumbent on the orthodontist to obtain adequate dental and medical cooperation in those cases in which the patient is suffering from rampant dental caries. A superficial questioning with respect to diet or casual observation as to the general health is not sufficient. We must remember the individualistic requirements of each child. They cannot all be reduced to an average. Ability and efficiency in handling particular foods differ widely between individual persons, and in the same person at different times. The nutritional demands of one may be far different from those of another. It is, therefore, the orthodontist's opportunity, as well as his responsibility, to advocate not only the repair of dental lesions, but also a careful study of the child as a whole, with a view to discovering the conditions which produce this susceptibility. It is not always easy to obtain the cooperation of the pediatrician or the physician. Many clinical practitioners of medicine are concerned only in obvious manifestations of disease. Not infrequently, the dentist is more concerned with repair than with prevention. The complexity of the factors and the immature state of our present knowledge all combine to make the problem in some instances extremely difficult, but the orthodontist who has the intelligence and perseverance to enlist the cooperation of the parents, dentist and physician may not only inhibit an annoying factor in orthodontics, but may furnish an avenue to systemic adjustment which may prove of inestimable value to the general health and development of his patients.

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FACTORS IN HUMAN SALIVA CORRELATED WITH THE OCCURRENCE OF SALIVARY CALCULUS

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LITTLE is known of the exact chemical and physical processes concerned in the formation of salivary calculus. Hypotheses involving carbon dioxide loss, colloidal changes, bacterial action and the operation of the enzyme phosphatase have been based almost entirely on experiments in which calculus-like masses were produced *in vitro*. A detailed review of these hypotheses was recently published by Rosebury and Karshan.[1]

From the work of Hall and Westbay[2] and of Bibby,[3] it appears that the p_H of the medium is unimportant in the formation of artificial deposits from stagnating saliva. The studies of Naeslund,[4] on the other hand, suggest that local increases in alkalinity of saliva, brought about by bacterial action, may be of importance in the formation of calculus. Presumably, precipitation would then result from an increase in PO_4 ions, derived from H_2PO_4 and HPO_4 ions.

It has been suggested that the enzyme phosphatase, which is capable of liberating inorganic phosphate from organic phosphate compounds in saliva, may play a rôle in the formation of calculus. The enzyme has been found by Adamson[5] in human gum tissue and by Smith[6] in desquamated epithelial cells in saliva.

That the protein content of the medium may be related to the formation of these deposits is suggested by the work of Karlstrom and Miller,[7] who found that precipitation of calcium salts was markedly reduced by the addition of soluble protein.

Since the main inorganic unit in salivary calculus appears to be tertiary calcium phosphate, it is reasonable to suppose that the concentration of calcium and phosphate in saliva is related to the tendency to form these deposits. Precipitation of tertiary calcium phosphate would depend on the type of phosphate ion present, which in turn is dependent on the hydrogen-ion concentration of the medium. Hence, a relationship may exist between the p_H of saliva and calculus formation.

In view of these considerations, it is surprising that no satisfactory effort seems to have been made to correlate individual differences in salivary p_H, calcium, inorganic phosphate and protein with differences in tendency to form calculus. The present study is an attempt to ascertain whether such a correlation exists. Forty-nine cases, persons ranging in age from twenty to fifty-two years, have been studied thus far. Twenty were calculus-free and had not had dental prophylactic treatment for at least one year. In the remaining cases, there were varying degrees of

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(This study was conducted with the aid of a grant for dental research from the Carnegie Corporation.)

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TABLE 1.—DATA ON SALIVARY ANALYSES OF CALCULUS-FREE AND CALCULUS GROUPS

Calculus-Free Group								Calculus Group							
Case	Number of Analyses	Age	Calcium	Inorganic Phosphorus	Protein	pH		Case	Number of Analyses	Age	Calcium	Inorganic Phosphorus	Protein	pH	
			Mg./100 Cc.			First Sample	Second Sample				Mg./100 Cc.			First Sample	Second Sample
14	3	26	6.5	9.3	288	7.13	7.37	1	3	36	5.3	12.6	187	6.86	6.97
								2	3	30	6.9	14.0	318	6.95	7.45
15	3	26	6.5	19.4*	336	7.10	7.37	4	3	24	6.3	11.6	184	7.32	7.62
19	3	46	5.5	13.7	267	7.02	7.43	5	3	48	6.9	14.5	284	7.17	7.32
20	3	33	4.4	14.1	340	6.93	7.13	7	3	50	6.8	13.8	256	7.35	7.60
22	3	35	4.9	12.8	262	7.25	7.48	9	2	35	7.6	13.9	296	7.10	7.28
								10	3	41	7.8	14.7	384	7.18	7.37
26	3	35	4.6	12.3	208	7.12	7.33	11	3	58	6.7	12.5	332	7.03	7.32
27	3	27	4.5	12.2	440	6.83	7.00	12	3	46	6.8	13.9	401	6.60	6.83
								13	3	52	5.7	12.3	289	6.98	7.37
28	3	38	6.0	11.4	379	7.12	7.32	16	1	47	6.1	11.4	428	7.10	7.30
29	3	36	4.4	8.8	486	6.63	6.66	18	3	30	4.8	12.9	351	6.95	7.33
								21	3	42	7.5	18.3	385	6.97	7.22
32	2	25	7.2	11.1	307	6.95	7.20	23	4	27	9.1	13.7	196	7.14	7.30
36	3	27	5.7	14.0	457	6.80	7.17	24	3	23	5.3	13.8	233	7.35	7.57
								25	3	43	7.2	13.3	378	6.80	7.10
39	3	23	4.4	13.0	287	7.18	7.33	30	3	40	6.3	13.7	203	7.42	7.52
41	3	24	4.5	9.2	312	6.50	6.93	35	3	37	7.9	16.4	312	7.05	7.13
								37	2	24	6.6	10.4	213	7.40	7.60
43	3	21	4.0	11.4	236	7.18	7.40	38	3	33	6.2	16.1	264	6.98	7.17
45	2	30	5.4	14.4	253	7.18	7.30	44	3	29	7.3	16.9	393	6.90	7.10
								47	1	28	7.8	15.0	209	7.15	7.30
51	2	23	3.5	7.4	334	7.13	7.15	48	3	22	6.8	11.7	226	7.32	7.42
55	1	20	3.7	9.5	246	6.80	6.80	49	3	29	5.4	12.0	304	6.95	7.12
								52	2	52	8.7	14.5	330	7.08	7.33
56	3	23	6.4	13.5	335	6.60	7.08	53	1	42	7.1	13.4	408	6.80	7.10
58	2	37	4.5	13.7	275	7.00	7.28	54	3	50	6.2	13.8	238	7.08	7.17
								57	3	49	4.5	12.1	284	7.25	7.45

60	1	21	5.3	11.5	222	7.25	7.40	59	3	38	8.0	11.8	227	7.28	7.42
Mean		29	5.1	11.8	314	6.99	7.21			38	6.7	13.6	294	7.09	7.30
Standard deviation			1.0	1.8	75.5	0.22	0.21				1.12	1.74	69.9	0.197	0.18
Standard deviation of mean			0.23	0.45	17.3	0.05	0.049				0.21	0.33	13.2	0.037	0.034
Average of average† deviation in per cent of individual cases			4.1	5.3	7.3	0.8	0.5				4.2	4.0	8.6	1.1	0.9

* This value was not used, since the difference between it and the mean is greater than four times the standard deviation. On reexamination, one year later, calculus was found in this person.

† These figures show the low degree of variation of the different analyses in each case.

deposits. Three sets of analyses were performed in 75 per cent of the cases; two sets were performed in 14 per cent.

METHODS

Saliva, stimulated to flow by the chewing of paraffin, was collected in three successive portions, from one to three hours after breakfast. The first portion (1 to 2 cc.), collected under paraffin oil, was used to determine the initial p_H; the second portion (10 to 12 cc.) was used for determination of calcium, inorganic phosphate and protein; the third portion (1 to 2 cc.), again collected under oil, was used for a second p_H determination. The analytical procedures were as follows:

Total Calcium.—Four cubic centimeters of saliva was added to 1 cc. of 40 per cent trichloracetic acid. After standing for ten minutes, the mixture was centrifuged and 3 cc. of supernatant fluid was analyzed as described by Krasnow, Karshan and Krejci.[8]

Phosphate.—The phosphate content was determined, on a separate portion (0.5 cc.) of the supernatant fluid used for the determination of total calcium, by Tisdall's[9] method for determining inorganic phosphate in blood.

Protein.—The procedure described by Karshan[10] was used.

The p_H was determined colorimetrically on saliva diluted 1:10, with bromthymol blue as the indicator; 0.25 cc. of a 0.04 per cent solution of the sodium salt of the indicator was mixed with 4.5 cc. of water under oil, and 0.5 cc. of saliva then added.

The statistical method employed[10, 11] for the interpretation of results is based on the assumption of homogeneity of the two groups studied; that is, on the "null" assumption that there is no difference between the two groups. All the values in each class (total calcium, inorganic phos-

TABLE 2.—COMPARISON OF SALIVARY ANALYSES OF CALCULUS-FREE AND CALCULUS GROUPS

Class of Value	Group	No. of Cases (N)	Number of Analyses	Group Mean (M)	Standard Deviation (σ)	Standard Deviation of Mean (σM)	Class Mean (M_0)	Difference Deviation of Class Mean (σM_0)	Difference of Means (D)	Standard Deviation of Difference (σD)	Significance Value $\frac{D}{\sigma D}$	Odds Against Random Occurrence of Difference
Calcium mg. %	Calculus-free	20	52	5.1	1.0	0.23	6.1	0.19	− 1.0	0.30	3.3	1,033 to 1
	Calculus	29	79	6.7	1.12	0.21			+ 0.6	0.28	2.1	27 to 1
Inorganic phosphate mg. %	Calculus-free	19	49	11.8	1.8	0.45	12.9	0.29	− 1.1	0.54	2.0	21 to 1
	Calculus	29	79	13.6	1.74	0.33			+ 0.7	0.44	1.6	8 to 1
Protein mg. %	Calculus-free	20	52	314	75.5	17.3	302	10.52	+12	20.2	0.6	1 to 1
	Calculus	29	79	294	69.9	13.2			− 8	16.9	0.5	< 1 to 1
*p*H first sample	Calculus-free	20	52	6.99	0.22	0.05	7.04	0.03	− 0.05	0.058	0.8	1.4 to 1
	Calculus	29	79	7.09	0.197	0.037			+ 0.05	0.047	1.1	2.7 to 1
*p*H second sample	Calculus-free	20	52	7.21	0.21	0.049	7.26	0.03	− 0.05	0.057	0.9	1.7 to 1
	Calculus	29	79	7.3	0.18	0.034			+ 0.04	0.045	0.9	1.7 to 1

phate, protein and p_H) in the two groups (calculus-free and calculus) were therefore pooled and each group mean (M) was compared with the pooled class mean (M_0) to test this assumption. By dividing the difference between these means by the standard deviation of the difference, a significance value was calculated, from which the odds against the random occurrence of the difference were obtained from tables[12] devised in accordance with the theory of probability.

RESULTS AND CONCLUSIONS

The data for individual cases are given in Table 1. A summary of the analytical data and the statistical analyses are given in Table 2. The most striking difference between the calculus-free and calculus groups appeared in the calcium content of the saliva. The mean value for calcium in the calculus-free group was lower than that in the calculus group, the former differing significantly from the class as a whole. This indicates that there is a significant difference in calcium between the two groups. The mean value of inorganic phosphate was likewise lower in the calculus-free than in the calculus group, and the difference between the mean of the calculus-free group and the class as a whole is probably significant. These data indicate that the calcium and, probably, the phosphate content of saliva are correlated with the occurrence of calculus. The mean p_H value was lower and the mean protein content was higher in the calculus-free than in the calculus group, but, on account of the variability within each group, the differences between the means in these respects are not statistically significant.

Studies along these lines on unstimulated saliva are in progress.

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THE THICKNESS OF THE HUMAN PERIODONTAL MEMBRANE

By EDGAR D. COOLIDGE, M.S., D.D.S., Chicago, Ill.

THERE has been much discussion in American dental literature concerning the effect of occlusal disharmony or traumatic occlusion upon the supporting structures of the teeth. The clinical significance of the various intensities and directions of occlusal stress are not easily interpreted. A thorough knowledge of the changes of the periodontal tissues in their reactions to different degrees of function is necessary at the outset. One of these factors to be investigated is the thickness of the human periodontal membrane at different ages and in teeth showing different types of occlusion.

Measurements of the periodontal membrane can be of value only when made on sections through human jaws with teeth in known occlusal relations. A considerable number of such jaws must be available in order to obtain fair averages. The interpretation of the occlusal relations of these jaws as they existed during life is by no means easy and simple. It is not difficult to find teeth without antagonists and to establish the thickness of their periodontal tissue, but to determine what degree of occlusal stress was present in occluding teeth is a more difficult matter and requires considerable thought and clinical experience. Tissue changes, such as occur in hemorrhage, thrombosis and necrosis of the soft tissue or fracture of the cementum are proof that teeth have been subjected to an excessive force, but conclusions as to immediate cause and clinical significance of these conditions should not be hastily drawn.

(From the Foundation for Dental Research of the Chicago College of Dental Surgery.)

(Read before the Section on Therapeutics, Pathology and Research at the Seventy-Third Annual Midwinter Meeting of the Chicago Dental Society, February 17, 1937.)

REVIEW OF THE LITERATURE

American dental literature is almost devoid of articles relating to the width of the periodontal space. General statements regarding the thickness of the periodontal membrane are frequently found, but no report of a series of measurements of this tissue around human or animal teeth has been made. Kronfeld[1] reported the measurements of several teeth in the jaws of a man thirty-eight years of age. The summary of his findings is given in Table 1.

The German literature contains several reports of measurements made to determine the thickness of the human periodontal membrane. Kellner[2] reported on the different characteristics of the cementum, alveolar bone and supporting bone around functioning and non-functioning teeth and gave a few measurements of the periodontal space. His findings were the first reported to show that the thickness of the periodontal membrane of functioning teeth is greater than that of non-functioning teeth, and that the cementum on non-functioning teeth is thicker than the cementum on teeth in function.

Klein[3] reported the first systematic measurements of the periodontal mem-

brane from a large number of human teeth in jaws from a collection at the Dental Institute of the University of Vienna. The occlusion of these teeth was known. Altogether, he made 950 measurements, which included the thickness of the tissue at the crest of the alveolus, the midroot, the apical region in each direction and at the bifurcation of multi-rooted teeth. Some teeth were sectioned in a bucco-lingual plane showing the periodontal membrane on the buccal and lingual root surfaces; others were sectioned in a mesio-distal plane. Klein's measurements were made on central sections only. He found the periodontal membrane thickest around teeth in heavy function. It was thicker in older persons than in the young. The average thickness for the ages between twenty and twenty-five he found to be 0.23 mm.; while between the ages of forty and fifty, the average thickness was 0.25 mm. For teeth in heavy function and standing alone, the average thickness of the periodontal tissue was 0.28 mm. Teeth with only one neighboring tooth showed an average thickness of the periodontal tissue of 0.26 mm.; while teeth with contact on both sides showed an average thickness of

TABLE 1.—COMPARISON OF PERIODONTAL WIDTH OF FUNCTIONING AND FUNCTIONLESS TEETH (KRONFELD, 1931)

	Heavy Function Left Upper Second Bicuspid Mm.	Light Function Left Lower First Bicuspid Mm.	Functionless Left Upper Third Molar Mm.
Average width of periodontal space at entrance of alveolus	0.35	0.14	0.10
Average width of periodontal space at middle of alveolus	0.28	0.10	0.06
Average width of periodontal space at fundus of alveolus	0.30	0.12	0.06

TABLE 2.—AVERAGE MEASUREMENTS OF THICKNESS OF PERIODONTAL MEMBRANE (KLEIN, 1928)

Average of all measurements	Age: 20-25 years 0.23 mm.	Age: 40-50 years 0.25 mm.	
Teeth in heavy function	Standing alone 0.28 mm.	One neighbor 0.26 mm.	Neighbor on each side 0.24 mm.
Teeth not in function	Average 0.20 mm.		
Average of all measurements	At crest of alveolar process in 260 cases 0.39 mm.	At midroot in 274 cases 0.17 mm.	At apex in 224 cases 0.21 mm.

TABLE 3.—DATA FROM EXPERIMENT OF PREISSECKER (1931)

Tooth with Antagonist		Tooth Without Antagonist	
	Mm.		Mm.
Crest	0.18	Crest	0.06
Midroot	0.13	Midroot	0.06
Apex	0.15	Apex	0.08

0.24 mm. Teeth not in function showed an average periodontal width of 0.20 mm. The average thickness at the alveolar crest was 0.39 mm.; at the midroot, 0.17 mm., and at the apex, 0.21 mm. Table 2 summarizes the findings reported above.

Again, in 1931, Kellner[4] reported on the relation of the thickness of the cementum and the periodontal tissue to function. His conclusion in regard to the thickness of the periodontal membrane was that it is thinner on non-functioning teeth than on teeth in function, but he reported no series of measurements. This paper further corroborated the former studies by him and Klein's measurements.

Preissecker[5] performed an experiment on rats in which he extracted the upper

TABLE 4.—DATA FROM EXPERIMENT OF JOZAT (1933)

Years	Average Thickness
	Mm.
25-27	0.29
37-44	0.31
60-79	0.37

or lower teeth on one side of the rat's mouth, leaving the opposite side in normal occlusion. Thus, he could observe the difference in thickness of the periodontal membrane in functioning and non-functioning teeth in the same animal. One example of the thickness of the periodontal membrane of functioning and non-functioning teeth in these animals is shown in Table 3.

Jozat[6] reported measuremets from 103 teeth in ten different jaws at the Dental Institute of the University of Berlin. His findings correspond in general to those of Klein, although his averages are slightly higher. He divided his material into three groups according to age. The thickness of the periodontal membrane of these groups is given in Table 4.

When his material was grouped according to function, findings were as follows: 1. Teeth under excessive stress caused by partial dentures, 0.398 mm. 2. Teeth in occlusion, 0.336 mm. 3. Teeth without antagonists, 0.280 mm. 4. Abutments of bridges and fixations, 0.249 mm.

In his summary, Jozat states that there are no absolute figures for the thickness of the periodontal membrane, but that the thickness of the membrane generally increases with advancing age. He found the smallest measurements on teeth carrying fixed bridgework and the largest measurements on teeth supporting partial denture clasps. Since the abutment teeth of fixed bridges carry a heavy additional load, the stabilizing factor of the bridge must have compensated for the increased function and this accounts for the thinner periodontal tissue. The teeth carrying partial denture clasps were subjected to heavy lateral stresses with less support and consequently were supplied with greater mobility to accommodate the demand. This seems to indicate that the thickness of the periodontal membrane is more dependent on the repetition of lateral or tipping stresses than on the mere factor of advancing age.

Both Klein and Jozat found that the thickness of the periodontal membrane increases with advancing age. This is contrary to the statements found in the writings of the following authors, although they do not give measurements to substantiate their statements:

G. V. Black[7] was probably the first investigator to deal specifically with the thickness of the periodontal membrane at different ages. In his monograph on the periosteum and the periodontal membrane, he states: "The thickness of the membrane varies very much in different individuals, and in different teeth in the same individual. It is thickest in the child, and it becomes thinner (normally)

as age advances until forty, or perhaps sixty years has been reached."

Bodecker[8] says, "With advancing age the periodontal membrane gradually becomes thinner as more cementum is deposited upon the root and more bone built into the alveolus." The following quotation is from Häupl and Lang[9]: "The thickness of the periodontal membrane is greater in young age and decreases in the adult." Noyes and Thomas[10] observed that the thickness of the periodontal membrane is reduced by bone building on the walls of the alveolus and the increase of cementum on the roots as age advances. Lenhossek[11] states, "It is of practical importance that the thickness of the periodontium decreases with advancing age apparently through deposition of bone and cementum on the alveolus and root. This explains the advancing passive motility of the teeth of children and adolescents which is advantageous in orthodontic work."

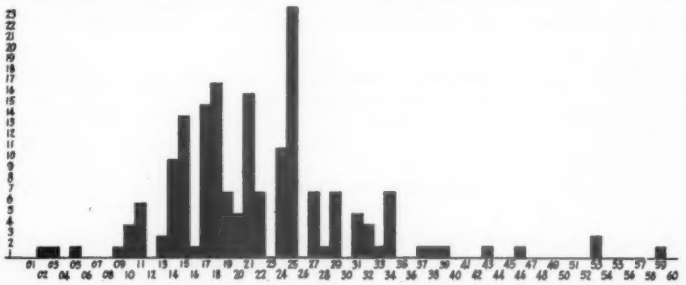

Fig. 1.—Graphic representation of thickness of periodontal membrane at alveolar crest of group of eighty-three teeth in Table 5 (ages eleven to sixteen years). The figures on the horizontal line represent the thickness of the periodontal membrane in hundredths of millimeters; the figures on the vertical line represent the frequency with which the various measurements are found. The greatest number of measurements fall at 0.25 mm. The arithmetical average is 0.22 mm. The arithmetical average for *all* measurements of these eighty-three teeth that appear in Table 5 is 0.21 mm., since the smaller measurements at the midroot reduce the total averages.

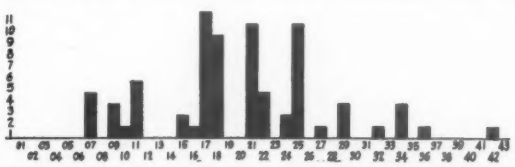

Fig. 2.—Graphic representation of thickness of periodontal membrane at alveolar crest of group of thirty-six teeth in Table 5 (ages thirty-two to fifty years). The figures on the horizontal line represent the thickness of the periodontal membrane in hundredths of millimeters; the figures on the vertical line represent the frequency with which the various measurements are found. The greatest number of measurements fall at 0.17 mm. The arithmetical average is 0.20 mm. The arithmetical average for *all* measurements of these thirty-six teeth as shown in Table 5 is 0.18 mm., since the smaller measurements at the midroot reduce the total averages.

AUTHOR'S INVESTIGATION

During the past year, the thickness of the periodontal tissue has been measured on 172 teeth in fifteen human jaws in the collection of the Foundation for Dental Research of the Chicago College of Den-

tal Surgery. Plaster casts were made of each jaw before the specimens were prepared for histologic study. The plaster casts were mounted on articulators to reproduce as nearly as possible the original occlusal relations of the teeth. Roentgenograms and photographs were also available of all jaws and teeth.

The total number of measurements was 1,145, including the thickness of the periodontal tissue at the crest of the alveolar bone, at the midroot, near the apex and in the bifurcation of multi-rooted teeth. The thickness was measured on the mesial and distal surfaces of ninety-three teeth, and on the buccal and lingual surfaces of seventy-nine teeth. Measurements on all four sides of the roots were made of twenty-three teeth, and the periodontal space in the bifurcation was measured in twenty-three multirooted teeth.

These measurements were made by means of a millimeter scale divided into 100 divisions and a graduated scale placed in the eyepiece of the microscope. The graduated scale in the eyepiece was measured by comparing it with the millimeter scale, which was placed on the stage of the microscope. Once the eyepiece scale had been measured by the magnified millimeter scale, the translation of the measurement into hundredths of millimeters was not difficult. Only central sections of roots, cut in the long axis of the tooth, were measured, cross-sections being taken from serial sections at the crest of the process, midroot and apex. All measurements were recorded in hundredths of millimeters omitting the third decimal. Since the exactness of the measurements of the periodontal tissue is more or less arbitrary, being influenced by the small

TABLE 5.—THICKNESS OF PERIODONTAL MEMBRANE OF 172 TEETH FROM FIFTEEN HUMAN JAWS (COOLIDGE, 1937)

	Average of Alveolar Crest	Average of Midroot	Average of Apex	Average of Tooth
Ages 11-16				
83 teeth from 4 jaws	0.23	0.17	0.24	0.21
Ages 32-50				
36 teeth from 5 jaws	0.20	0.14	0.19	0.18
Ages 51-67				
35 teeth from 5 jaws	0.17	0.12	0.16	0.15
Age 25 (1 case)				
18 teeth from 1 jaw	0.16	0.09	0.15	0.13

TABLE 6.—THICKNESS OF PERIODONTAL TISSUES IN VARYING CONDITIONS OF FUNCTION

	Alveolar Crest Mm.	Midroot Mm.	Apex Mm.	Average Mm.
Teeth in heavy function				
44 teeth from 8 jaws	0.20	0.14	0.19	0.18
Teeth not in function				
20 teeth from 12 jaws	0.14	0.11	0.15	0.13
Embedded teeth				
5 teeth from 12 jaws	0.09	0.17	0.18	0.08
Malposed and drifting teeth	0.22	0.16	0.18	0.19

irregularities of alveolar bone and root surface, a slight variation of a few thousandths of a millimeter could be obtained by a slight change in the location of the measured point on the root surface, and would therefore be of no significance.

The material to be studied was divided into four groups according to age. Jaws from subjects of from eleven to sixteen years became Group 1. One jaw, from a subject of twenty-five years, stands in a group by itself because of its peculiarly thin periodontal tissue. Jaws from those thirty-two to fifty years were placed in

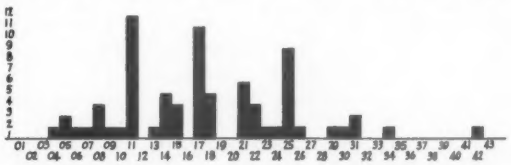

Fig. 3.—Graphic representation of thickness of periodontal membrane at alveolar crest of group of thirty-five teeth in Table 5 (ages fifty-one to sixty-seven years). The figures on the horizontal line represent the thickness of the periodontal membrane in hundredths of millimeters; the figures on the vertical line represent the frequency with which the various measurements are found. The greatest number of measurements fall at 0.11 mm. The arithmetical average is 0.17 mm. The arithmetical average for *all* measurements of these thirty-five teeth as shown in Table 5 is 0.15 mm., since the smaller measurements at the midroot reduce the total averages.

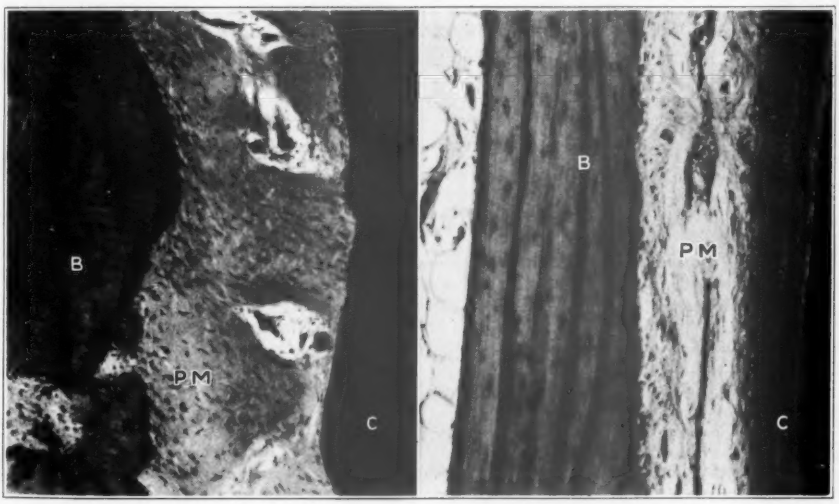

Fig. 4.—Comparison between the periodontal membrane of molar in heavy occlusion and molar without antagonist (Table 8). Left: Periodontal membrane of molar in heavy occlusion. C, cementum; PM, periodontal membrane; B, alveolar bone. The periodontal membrane, which is strong and fibrous, is 0.22 mm. thick. Right: Periodontal membrane of molar without antagonist. C, cementum; PM, periodontal membrane; B, alveolar bone. The periodontal membrane, which is weak and atrophic, is 0.13 mm. thick. (×150.)

Group 2, while Group 3 was made up of jaws from subjects over fifty, ranging from fifty-one to sixty-seven years. Aside from age, several other classifications were made. Teeth from jaws with only a few teeth, which bore an extra burden of mastication, were selected as teeth in heavy function. Teeth with no antagonists were selected as teeth without function. Unerupted and embedded teeth made a group, and teeth that were crowded away or that had drifted from their normal position formed another group.

The group ranging from eleven to sixteen years comprised four jaws. The periodontal tissue was measured in thirty-nine teeth in bucco-lingual sections and forty-four in mesio-distal sections, a total of eighty-three teeth. The average of the measurements of this group are summarized in Table 5, while the individual jaw averages may be found in Table 12.

In the thirty-two to fifty-year age group, which included five jaws, the periodontal tissues were measured on thirty-six teeth, thirteen in buccolingual sections and twenty-three in mesiodistal sections. Their averages are summarized in Table 5. It will be observed that these periodontal tissues are on the average a little thinner than those of the younger group.

The next group was made up of five jaws of subjects between fifty-one and sixty-seven years of age and contains thirty-five teeth, twenty-four of which

TABLE 7.—COMPARISON OF THICKNESS OF PERIODONTAL MEMBRANE OF FOUR INCISORS AND FOUR MOLARS (JAW 17, SUBJECT AGED ELEVEN YEARS)

	Alveolar Crest Mm.	Midroot Mm.	Apex Mm.	Average Mm.
Four lateral incisors	0.33	0.25	0.28	0.29
Four molars	0.22	0.15	0.26	0.21

TABLE 8.—COMPARISON OF THICKNESS OF PERIODONTAL MEMBRANE OF MOLAR IN HEAVY OCCLUSION AND OF MOLAR WITHOUT AN ANTAGONIST (JAW 35, SUBJECT AGED FIFTY-FOUR)

	Alveolar Crest Mm.	Midroot Mm.	Apex Mm.	Average Mm.
Lower left second molar in heavy occlusion	0.28	0.13	0.18	0.20
Lower right second molar without antagonist	0.14	0.09	0.08	0.10

TABLE 9.—COMPARISON OF THICKNESS OF PERIODONTAL MEMBRANE OF ERUPTED MALPOSED MOLAR AND OF COMPLETELY EMBEDDED MOLAR (JAW 47, SUBJECT AGED THIRTY-EIGHT)

	Alveolar Crest Mm.	Midroot Mm.	Apex Mm.	Average Mm.
Erupted lower left third molar	0.33	0.13	0.11	0.19
Completely embedded lower right molar	0.13	0.13	0.13	0.13

were measured in bucco-lingual sections and eleven in mesio-distal sections. The average of these groups shows a still thinner periodontal tissue than either of the younger groups.

The jaw of the one individual of twenty-five years (K24) contained eighteen teeth that were measured for periodontal tissue thickness: three in bucco-lingual sections and fifteen in mesio-distal sections. These averages are the smallest of the measurements made in the four groups. At this age, the teeth are usually in full function and the narrowing of the periodontal space of non-functioning teeth due to the loss of antagonists has not yet become a factor in altering the thickness of the periodontal tissues. Therefore, we believe this to be an individual peculiarity, similar to the inexplicable occurrence of unusually large or small teeth.

A selection of forty-four teeth from eight jaws showing heavy function was made to investigate the thickness of the periodontal tissues where a greater stress was resisted (Table 6). Bucco-lingual measurements were made on twenty-three teeth and mesio-distal measurements on twenty-one teeth. Among these teeth in heavy function, there were four teeth from the youngest group, twenty-five teeth from the thirty-two to fifty-year-old group and seventeen teeth from the oldest group. These teeth were subjected to heavy function because of the requirement placed on them to sustain the masticating forces and because of the relation of these remaining teeth to the forces applied.

It appears from these figures that the periodontal space grows narrower with age except around teeth that are subjected to an extra burden, while the thickness of the periodontal space around teeth in heavy function varies as an individual characteristic, depending on the type of stress. The degree of leverage exerted on the tooth is an important factor in widening the periodontal space, as appears in the next three classes of Table 6.

TABLE 10.—COMPARISON OF PERIODONTAL MEMBRANE OF MOLAR IN HEAVY OCCLUSION AND OF TWO BICUSPIDS IN NORMAL OCCLUSION (JAW 52, SUBJECT AGED FIFTY-ONE)

	Alveolar Crest Mm.	Midroot Mm.	Apex Mm.	Average Mm.
Lower left third molar in heavy occlusion	0.24	0.19	0.21	0.21
Left first bicuspids in normal occlusion	0.18	0.13	0.17	0.16

TABLE 11.—COMPARISON OF PERIODONTAL MEMBRANE ON LABIAL AND LINGUAL SIDES AND ON MESIAL AND DISTAL SIDES IN THREE CROWDED INCISORS (JAW 62, SUBJECT AGED ELEVEN)

	Mesial Mm.	Distal Mm.	Labial Mm.	Lingual Mm.
Upper right central incisor, mesial and labial drift	0.12	0.24	0.12	0.22
Upper left central incisor, no drift	0.21	0.19	0.24	0.24
Upper right lateral incisor, distal and labial drift	0.27	0.17	0.11	0.15

The average measurement of erupted teeth with no antagonists in the study of twenty teeth from twelve jaws is 0.13 mm., which is very much lower than the average of all jaws measured with the exception of that of the twenty-five-year-old subject (K24). Had this one jaw not been included in this study, a different interpretation might have been made of these figures. The measurements made by Klein in persons of twenty to twenty-five years averaged 0.23 mm.; while his group of teeth not in function averaged 0.20 mm. More measurements of the periodontal tissues of persons from 20 to 30 years should be made to clear up this question. The measurements by Jozat are slightly larger at all ages, but those of teeth not in function at 0.28 mm. are only slightly lower than those of the ages twenty-five to twenty-seven years, which were 0.29 mm. This may indicate that the periodontal tissues in normal function are thinner in early adult life than either earlier or later in life.

Embedded teeth found in five jaws were measured. The thickness of the periodontal membrane of these teeth varied from 0.01 to 0.14 mm., the average being 0.08 mm.

Malposed and drifting teeth were found to have a relatively thick periodontal membrane. There were fifteen teeth found in eight jaws of this type. The measurements of these varied from 0.07 to 0.37 mm., with an average of 0.19 mm.

It having been observed that the periodontal tissue thickness had variations in individual teeth in the same jaw greater than the variations in all measurements made in different jaws, the next four

TABLE 12.—INDIVIDUAL JAW AVERAGES

		Buccal			Lingual				Mesial			Distal			
Group 1															
Jaw	Age	No. Teeth	Crest	Mid	Apex	Crest	Mid	Apex	No. Teeth	Crest	Mid	Apex	Crest	Mid	Apex	Average
17	11	5	.23	.21	.31	.32	.25	.21	5	.24	.19	.31	.35	.14	.29	.25
62	11	13	.25	.20	.28	.22	.24	.29	13	.18	.18	.23	.20	.17	.22	.22
18	14	14	.19	.14	.21	.19	.14	.21	11	.22	.18	.21	.19	.14	.20	.18
19	16	7	.23	.10	.18	.18	.13	.15	15	.22	.12	.18	.22	.14	.18	.17
Individual Jaw															
K24	25	3	.14	.09	.15	.15	.09	.15	15	.18	.09	.15	.16	.10	.16	.13
Group 2															
49	32	6	.19	.13	.22	.21	.15	.16	6	.20	.14	.17	.16	.13	.14	.17
47	38	1	.25	.17	.11	.28	.17	.21	4	.22	.14	.13	.22	.17	.19	.19
41	42	..	...	...	...	...	...	...	5	.23	.16	.21	.25	.13	.20	.19
39	..	1	.11	.09	.31	.17	.07	.14	..	...	...	...	...	...	...	.15
20	50	5	.24	.16	.21	.19	.19	.25	8	.14	.11	.15	.16	.11	.18	.18
Group 3															
21	51	3	.12	.12	.23	.16	.16	.12	1	.25	.16	.17	.25	.08	.09	.16
52	52	5	.16	.11	.18	.16	.14	.16	5	.17	.14	.16	.21	.16	.16	.16
35	54	10	.17	.15	.18	.18	.13	.16	2	.21	.12	.16	.21	.09	.09	.15
23	..	1	.05	.11	.20	...	...	.25	2	.22	.17	.19	.13	.15	.19	.18
38	67	5	.14	.14	.13	.16	.12	.17	1	.08	.07	.08	.25	.08	.11	.13

tables were made to substantiate such a statement.

In Table 7, the comparison of the thickness of the periodontal membrane of four incisors and four molars in one of the youngest subjects, aged eleven years (Jaw 17), is shown. The study of this jaw leads to the conclusion that the child had gritted his teeth with great force during the latter days of his life. The four molars show in the hemorrhagic and necrotic areas about their roots definite effects of both lateral and end-to-end stress. The anterior teeth all showed the effect of horizontal stress.

The average of the measurements on the four incisors is 0.29 mm., while the average for the four molars is only 0.21 mm.

In Table 8, a molar in heavy occlusion is compared to one without an antagonist (Jaw 35, subject aged fifty-four years). It shows a periodontal tissue thickness of 0.20 mm. as compared to 0.10 mm. in the non-functioning molar.

Table 9 is a comparison of the thickness of the periodontal membrane of an erupted, but malposed, third molar subjected to a heavy tipping stress, and a completely embedded third molar in jaw 47 (subject aged thirty-eight years). The former has an average thickness of 0.19 mm., the latter, of 0.13 mm.

In Jaw 52 (subject aged fifty-one years), a third molar under very heavy occlusion was found to measure 0.21 mm.; while two opposing bicuspids on the same side of the jaw in good occlusion were found to have a periodontal membrane thickness of 0.16 mm.

It is often possible to determine by the pressure and tension areas the type of stress to which a tooth has been subjected. However, if a tooth is gently forced from its position by pressure, the bone is rapidly resorbed in front of the moving tooth and built in again in its wake, and soon a normal periodontal space for that tooth is established. If a force from two directions keeps pushing a tooth forward and back, the periodontal space becomes greatly enlarged as we have seen in malposed and drifting teeth. In Table 11, the measurements of the periodontal membrane thickness of three incisors are shown. In Jaw 62 (subject aged eleven years), the right upper central incisor was crowded out of line by the eruptive pressure of the cuspid and bicuspid, the left central incisor being in good position. The averages of the measurements of the buccal and lingual and the mesial and distal surfaces of the roots are compared. They show that the right central incisor has a comparatively thin periodontal membrane on the mesial and labial surfaces and a thick periodontal membrane on the distal and lingual surfaces. In other words, there is evidence of the mesial and labial drift that was shown in the photograph and the plaster cast made before preparing the specimen for histologic study. The right lateral incisor has a comparatively thin periodontal membrane on the distal and labial surfaces and a thick periodontal membrane on the mesial and lingual surfaces. This indicates a drift in a distal and labial direction. Comparison of these figures with those obtained in measuring the upper left central incisor, with its nearly uniform periodontal membrane thickness, indicates a stationary position of that tooth.

SUMMARY AND CONCLUSIONS

1. A review was made of the available knowledge regarding the thickness of the human periodontal membrane. Two reports by Klein and Jozat on measurements of the periodontal membrane were found in German literature. No detailed study of the subject has appeared in this country.

2. This report is based on 1,145 meas-

urements made of the periodontal membrane in 172 teeth from fifteen human jaws. Only central sections were used for this purpose. The thickness of the periodontal membrane was measured at the alveolar crest, at the midroot and the apex, and in multirooted teeth at the bifurcation.

3. On the whole, our averages of the thickness of the periodontal membrane are somewhat smaller than the corresponding averages of Klein and Jozat. The average for the age group eleven to sixteen years is 0.21 mm.; for the age group thirty-two to fifty years, 0.18 mm., and for the group fifty to sixty-seven years, 0.15 mm. This is contrary to the observations of Klein and Jozat, who state that the average thickness of the periodontal membrane increases with advancing age, but supports the statements found in the writings of Black, Bodecker, Häupl and Lang, Noyes and Thomas, and Lenhossek.

4. The average thickness (regardless of age) of the periodontal membrane of those teeth subjected to heavy function is 0.18 mm.; of teeth without antagonists, 0.13 mm., and of embedded teeth, 0.08 mm. This indicates that the thickness of the periodontal membrane in each jaw is in direct ratio to the intensity of masticatory function.

5. In one jaw of a person of 25 years, the measurements of all teeth are considerably smaller than the other averages. Such individual variations must be considered carefully, since averages taken from single jaws may be misleading.

6. A relatively thick periodontal membrane was found with malposed, loose and drifting teeth, the average being 0.19 mm. These teeth were subjected to a greatly increased lateral or horizontal stress, which was abnormal. Many areas of necrosis of the soft tissue were found on the side of pressure and many areas of fracture of the cementum on the side of tension.

7. In drifting teeth, the periodontal membrane is considerably thinner on the side toward which the tooth is moving (side of pressure) and correspondingly wider on the opposite side (side of tension).

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DECALCIFICATION OF TEETH AS A RESULT OF OBSTIPATION WITH LONG CONTINUED VOMITING: REPORT OF A CASE*

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History.—A woman, aged 26, a school teacher and a native of Mississippi, came to this clinic June 22, 1935, because of a life-long constipation which had been very obstinate. She had never had a bowel movement without the use of cathartics or enemas. As she grew older, the condition became worse. Twelve years ago, she began to vomit occasionally, the condition becoming progressively worse until, during the last six years, she had vomited after nearly every meal. The last few years, the vomiting had been somewhat projectile and had occurred almost as soon as food reached the stomach. Many physicians had been consulted, without substantial relief. Early in 1935, the serum calcium was found to be decreased and parathyroid extract and calcium gluconate were prescribed. About the same time, injections of double strength pituitrin were begun. These, plus an enema, had caused bowel movements, and since the evacuations had been so much more satisfactory than previously, the patient had continued this treatment for many months.

General Examination.—When the patient was examined at this clinic, she was literally a "walking skeleton," her weight being 72 pounds (32.7 kg.) and height 5 feet, 4 inches (162.6 cm.). The systolic and diastolic blood pressures were, respectively, 92 and 58 mm. of mercury. The value for the hemoglobin was 9.7 gm. per hundred cubic centimeters of blood. The erythrocytes numbered 3,460,000, the leukocytes 3,600 per cubic millimeter of blood. A differential count of the leukocytes was as follows: 41.0 per cent lymphocytes, 4.0 per cent monocytes, 51.0 per cent polymorphonuclear neutrophils, 2.0 per cent eosinophils and 1.0 per cent basophils. The values for the gastric acidity were 40 and 20, respectively, for the total and free hydrochloric acid with a 120 cc. test meal, and according to the method of Töpfer. Roentgenologic examination of the stomach, esophagus and duodenum did not reveal any abnormality. Roentgenologic studies of

Fig. 1.—Elongated and dilated colon. (This and the illustrations following are from an article by the authors published in the American Journal of Digestive Diseases and Nutrition, May, 1936.)

*From the Division of Medicine and the Section on Dental Surgery, The Mayo Clinic.

the colon showed it to be long and somewhat dilated (Fig. 1). There was no evidence of intrinsic disease. Numerous urinalyses disclosed that the urine was normal.

Oral Examination.—A peculiar finding was the erosion of the anterior teeth (Fig. 2) and occluding surfaces. One of us immediately suspected that these dental changes were the result of the continuous and repeated vomiting. It will be noted that, because of loss of substance, the anterior teeth do not occlude and that only

Fig. 2.—Two views showing erosion of anterior teeth as result of emesis of long standing.

the molar teeth are in occlusion. It was found that the lingual surface of all the anterior teeth, both upper and lower, were affected. The enamel had disappeared and the underlying dentin was exposed. The labial surfaces were not affected at all. The incisor teeth were shortened considerably and the incisal margins were very sharp. In the molar teeth, the occlusal surfaces were chiefly involved. Fillings appeared as elevated islands of metal (Fig. 3).

The saliva, which had a p_H of 8.0, had been normal at all times.

The patient became aware of the dental condition about three years ago, because of sensitivity to thermal changes, etc., with gradual increase of discomfort. The teeth were very sensitive and protective measures were inadvisable until regurgitation had been controlled. This condition is similar to erosion resulting from the use of hydrochloric acid in the treatment of achlorhydria. In such cases, the labial surfaces of the teeth are decalcified. It was learned that vomiting had occurred some little time after eating and that the food had been

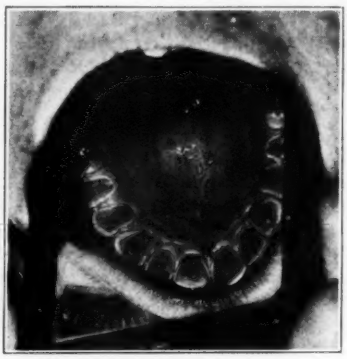

Fig. 3.—Effect of emesis of long standing on teeth with fillings.

swallowed several times. Rumination is rather common among human beings, and probably not much damage is done to teeth except when it occurs at night and allows the gastric contents to remain in the mouth for a long time. The habit occasionally may be responsible for the condition spoken of as "soft teeth."

Treatment and Outcome.—After a thorough discussion of the condition, a rigid anticonstipation diet was given. Three liters of liquid daily and 15 drops of tincture of belladonna three times a day were given. The patient was also given one sixtieth grain (0.0011 gm.) of physostig-

mine salicylate twice a day by mouth. The bowels began to move, the vomiting ceased and, during a period of weeks, there was a gradual return to normal function. As this occurred, the administration of physostigmine salicylate was discontinued. When the patient was dismissed, she was advised to take a bulky type of diet and adequate amounts of liquids. During the six weeks in which this program was continued, she gained 10 pounds (4.5 kg.) and felt very well.

SURGICAL ERADICATION OF PERIODONTOCLASIA; METHOD OF APPLYING SURGICAL PACK AND POSTOPERATIVE TREATMENT

By A. C. HITZELBERGER, D.D.S., Utica, N. Y.

THE old adage, "There is nothing new under the sun," applies to surgical procedures in the practice of dentistry. Prinz, in his book, "Diseases of the Soft Tissues," records that, as early as 1851, Joseph Linderer operated on the central incisors. He cut away all the soft tissues of the affected structures. In 1885, Robiscek cut away the gum in single-rooted teeth as far as the pocket extended and removed granulation tissue with silver nitrate. Pickerill, in his book, "Stomatology in General Practice" (1912), gives a detailed description of this operation, referring to it as "gingivectomy," a term later revived by Ziesel, Nodine and others. In 1915, G. V. Black recounted in detail his method; and, in 1916, Leonard Widman presented a paper before the Scandinavian Dental Association on a flap operation. In 1919, Zentler published a reprint of the flap operation as presented by Widman. Many other prominent men advocated the different types of operations.

In 1917, I began to practice gingivectomy, experimentally. Whenever the opportunity presented itself, I operated, carefully tabulating the results. At that time, my objections to this method of surgical procedure were the following: (1) postoperative pain due to the lack of some material to cover the bone and the nerve ends; (2) the unsatisfactory control of the formation of granulation tissue, and (3) the hypersensitivity of the teeth.

After reading Zentler's articles, I decided to look into the flap operation that Widman was recommending. I spent several weeks at the Columbia University Clinic watching Zentler operate and following the results of his cases. I adopted this method wherever it was applicable and later developed the individual flap method, a modification of the Zentler method, but instead of laying back a flap over three or four teeth, I laid back a flap in the interproximal spaces of the teeth, which lessened trauma around the unaffected bone. I used this method until 1928, when an antiseptic surgical dressing was introduced. At that time, I reverted to gingivectomy. My change from the flap operation to gingivectomy was not merely a whim, but the result of observation and comparison of the flap

(Read at the Eighteenth Annual Meeting of the American Society of Oral Surgeons and Exodontists, San Francisco, Calif., July 11, 1936.)

method and previous gingivectomies. I found that the tissue, after the gingivectomy, was firmer and more resistant to the toothbrush if the patient had followed instructions and returned for the periodical examination and prophylaxis. In many cases, I found the flap operation undesirable because it was impossible to lay back a suitable flap when the tissue was badly infected.

The greater percentage of my periodontoclasia cases are referred to me by the internist. Obviously, there is no compromising in these cases. I was obliged to show the internist definitely that the disease could be eradicated without resorting to forceps. I positively could not do so with subcurettage or more conservative treatment. Today, I am able to return the patient to the internist and definitely say that the infection has been eradicated without the removal of teeth. This is not only a source of satisfaction to the operator, but also has earned the gratitude of the patient.

When the entire mouth is to be operated on, it is possible to have the mucosa in such condition in from four to six weeks that the patient may use the toothbrush vigorously. Of course, there are always a few exceptions to the rule.

A phase of this operation which affords me great satisfaction is the mental attitude of patients after the operation has been completed. They are like children, open to suggestions and willing to accept any advice offered them regarding the care of the mouth. They are taught what periodontoclasia really means. In the simplest terms, I explain how the infection is spread, from its incipiency to the time when the tooth will be exfoliated. Not only by oral explanation but also, and more graphically, by the use of models, the patient observes and understands the healthy condition and the advanced stages of the disease. If we spent more time educating patients in the prevention of the disease, the necessity for operative work would be reduced and greater mouth health would be the result.

I find that more than 80 per cent of the patients who have been operated on are eager to cooperate with me in the home care of the gums and teeth. If we feel that they are not willing to do their part, we should not operate, as much of the success of the operation depends on the wholehearted cooperation of the patient.

Briefly, my procedure is as follows:

1. Clinical examination of the mouth.
2. Roentgenographic survey.
3. Compilation of the roentgenographic findings with the results of the clinical examination.
4. An explanation to the patient of the difference between normal and abnormal conditions; demonstration by roentgenogram of what a pocket is and what the normal condition should be; presentation of models and photographs to help the patient visualize these conditions.
5. Presentation of casts of cases before and after operation and photographs of finished cases. (This procedure is imperative. The patient is very apt to be shocked when the plasters are removed to find the mucosa of the teeth so unsightly. By preparing the patient, we save ourselves much embarrassment and endless explanation.)
6. The initiation of routine treatment for Vincent's infection four days before operating. (This is continued until the day of operation.)
7. Advice to the patient as to the necessity for a physical examination and a report from the internist, and emphasis on the importance of thorough examination of the heart and kidneys and tabulation of the bleeding and clotting time.

ENAMEL DECALCIFICATION BY MOUTH ORGANISMS AND DENTAL CARIES: A SUGGESTED TEST FOR CARIES SUSCEPTIBILITY

By LEONARD S. FOSDICK, Ph.D.; HAROLD L. HANSEN, Ph.D., and CHARLOTTE EPPLE, B.S., Chicago, Ill.

FOR many years, the subject of dental caries has been a topic of much concern to both dental practitioners and research workers. The field today seems to be divided into two groups, one maintaining local environment to be the primary factor in dental caries; the other, diet.

Although many publications touching on the physicochemical properties of saliva have appeared in the past, no critical study of its solvent power in the presence of carbohydrate has been recorded.[1] The lack of such information prompted this investigation, and it is hoped that studies from this point of view may lead to a clearer conception of the nature of dental caries.

In order to make a chemical investigation of the solubility of human enamel under any conditions, it would be helpful to know the nature of the material with which we are dealing. The value[2] commonly given for the composition of human enamel is $CaCO_3nCa_3(PO_4)_2$, where n is greater than two and less than three. The investigations of Klement and Trömel[3] suggest that the formula is $Ca_{10}(PO_4)_6(OH)_2$, a hydrated tricalcium phosphate. They further say that small amounts of calcium carbonate and other compounds present are not constituents of the compound, but exist as impurities. Also they state that $Ca_{10}(PO_4)_6(OH)_2$ is the only stable form of calcium phosphate which can exist under the conditions that prevail in the system. Their conclusions are based on a roentgenographic analysis of bone and teeth.

From the titration curves of calcium hydroxide and phosphoric acid,[4] it is obvious that tricalcium phosphate, or the hydrated form, is not stable below a p_H of 5 in water solution. Enright, Friesell and Trescher[5] demonstrated this in their work on human enamel. They found that the p_H of 5 was the critical p_H in regard to the etching of human enamel in buffered solutions saturated with calcium and phosphate ions.

EXPERIMENTAL

In the following experiments, we have tried to simulate to a large extent the conditions which may exist in the "unclean" areas of the mouth. We have made an attempt to determine the solubility of human enamel in human saliva in the presence of sugar.

In most of the experiments, the saliva flow was stimulated by the chewing of gum, which also furnished the sugar. Comparative results can be obtained with paraffin-stimulated saliva if a concentration of about 5 per cent glucose is added. About 20 cc. of saliva was collected in

(From the Northwestern University Dental School, Department of Chemistry.)

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sterile flasks for each test. The enamel was prepared by drying whole sound teeth at 100° C. under a pressure of 15 mm. Hg. It was found that this process would cause the dentin to shrink from the enamel. The enamel was then chipped from the teeth, examined for dentin and powdered in a mortar. The powdered enamel was passed through a 300-mesh screen to secure particles of approximately the same size.

TABLE 1.—ACTION OF STERILE HUMAN SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR*

Patient	Mg. Calcium 100 Cc. Before	Mg. Calcium 100 Cc. After	p_H Before	p_H After
I Immune				
1	8.5	3.8	7.4	7.4
2	8.0	3.8	7.9	7.9
3	8.2	4.0	7.9	7.8
4	8.0	3.8	7.4	7.4
5	8.5	3.8	7.8	7.6
6	7.5	4.4	7.6	7.6
II Susceptible				
1	8.5	4.3	7.2	7.4
2	8.0	4.1	7.2	7.2
3	7.7	4.9	7.4	7.4
4	7.5	3.4	7.8	7.8
5	8.2	3.8	7.2	7.2
6	8.0	3.8	7.2	7.2
7	6.0	4.3	7.2	7.2
8	6.8	4.3	7.8	7.6
9	8.2	4.1	7.4	7.4
10	8.0	4.1	7.2	7.2

*Shaking, eighteen hours.

TABLE 2.—ACTION OF STAGNANT HUMAN SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR*

Patient	Mg. Calcium 100 Cc. Before	Mg. Calcium 100 Cc. After	p_H Before	p_H After
III Immune				
1	11.5	103.7	6.4	4.6
2	8.7	47.8	6.6	5.4
3	8.6	61.5	6.8	5.2
4	8.5	53.6	6.8	5.2
5	9.5	42.7	7.0	5.2
6	10.1	35.0	7.2	5.4
IV Susceptible				
1	8.9	96.7	7.0	4.6
2	8.2	46.5	6.8	5.2
3	6.5	70.5	6.4	4.4
4	9.3	25.3	6.8	5.2
5	6.1	38.7	6.8	5.4
6	7.9	52.5	7.0	5.4
7	9.0	48.8	7.0	5.4
8	6.7	65.0	6.4	4.6
9	10.0	88.8	7.2	4.8
10	9.3	49.5	6.6	5.0

*Shaking, eighteen hours.

ACTION OF FRESH SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR

About 25 cc. of gum-stimulated human saliva was gathered and the p_H taken. A portion was analyzed for calcium and the rest placed in an 8-inch tube with about 0.1 gm. of powdered human enamel. The saliva was either sterilized by heat or preserved with toluene and the tube sealed. The tube was shaken at body temperature 37.5° C. for eighteen hours. It was then removed and the contents were centrifuged to take out the undissolved enamel. The clear solution was analyzed for calcium. The difference between the original calcium content of the saliva and the calcium content after shaking was taken as a measure of the solvent action of the fresh saliva on human enamel. This experiment was performed on saliva from both susceptible and immune mouths.

ACTION OF STAGNANT SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR

About 25 cc. of gum-stimulated saliva was gathered, and a portion analyzed for calcium. The remainder was sealed in an 8-inch tube with 0.1 gm. of powdered human enamel and shaken for eighteen hours at body temperature. The tubes were then removed and the centri-

fuged contents were analyzed for calcium. The difference between the original and final calcium content of the saliva was taken as a measure of the action of stagnant saliva on human enamel. This experiment was tried with saliva from susceptible and from immune patients.

INFLUENCE OF PARTIAL STAGNATION OF HUMAN SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR

About 25 cc. of gum-stimulated saliva was gathered and the p_H taken and a portion analyzed for calcium. The remainder was sealed in an 8-inch test tube and shaken for from four to five hours. The tube was then opened and a few drops of chloroform added to stop any bacterial action and growth. The tube was then sealed and the shaking continued for a period of fourteen hours, to allow a condition of equilibrium to be reached. The tube was removed and the p_H taken and the saliva analyzed for calcium.

TABLE 3.—INFLUENCE OF PARTIAL STAGNATION OF SALIVA ON HUMAN ENAMEL IN THE PRESENCE OF SUGAR

Patient	Mg. Calcium 100 Cc. Before	Mg. Calcium 100 Cc. After	p_H Before	p_H After
V Immune				
1	8.8	8.8	7.4	7.4
2	7.7	4.5	7.4	7.4
3	7.6	4.5	7.4	7.2
4	8.4	12.5	6.8	6.6
5	6.8	6.8	7.0	6.8
6	5.8	7.7	7.2	7.2
VI Susceptible				
1	7.8	18.5	7.0	6.6
2	7.7	19.6	6.8	6.6
3	6.5	14.6	6.2	6.0
4	7.4	16.5	7.2	6.6
5	8.7	14.9	6.8	6.6
6	6.6	24.6	6.8	6.6
7	6.4	19.2	6.8	7.0
8	6.2	20.5	7.4	6.6
9	6.2	14.5	7.2	6.8
10	6.8	17.5	7.4	6.8

The accompanying tables show the results obtained in the foregoing experiments.

From these results, it can be said that all human saliva is saturated or supersaturated with calcium phosphate. The results indicate, however, that any saliva, if allowed to stagnate in the presence of sugar, will decalcify the teeth. Even though there is a marked similarity between the action in the immune and in the susceptible, there was found to be a marked difference in the rate at which the two types of saliva acted on the enamel in the presence of sugar. Owing to the fact that in these experiments there is an apparent difference in the two types of saliva, it was decided to set up a procedure to test chemically the susceptibility of a series of patients and to determine the error in the analysis. The procedure was changed in a slight degree to shorten and simplify it as well as to determine the bacteria present. The final procedure is as follows:

About 25 cc. of gum-stimulated saliva is gathered in a sterile flask and a portion is analyzed for calcium and a quantitative bacteriologic count is made on neutral and acid specimens with agar. The remainder is placed in a sterile 8-inch testtube with about 0.1 gm. of powdered human enamel. The tube is then sealed and shaken for four hours at body temperature. The tube is removed and another bacteria count is made, as well as a calcium determination. The results in a few cases are given in Table 4.

As can be seen, the results show a marked difference between the susceptible and the immune cases. The test has been tried with at least two checks on 325 patients, and they have been in correlation with clinical evidence in 85 per cent of cases. A complete report on the test will

be made when 1,000 cases have been analyzed.

As complete bacteriologic data were kept during all the test, it was hoped that some correlation could be made between susceptibility and occurrence of organisms. The only possible correlation was a general trend toward predominance of yeast and *B. acidophilus* in the susceptible cases. The numbers and kinds of organisms fluctuated so much from case to case that it was decided to determine the effect of pure strain and mixed organisms on the decalcification of enamel in human saliva in the presence of carbohydrate. This was done by the following method:

Saliva was gathered and a sample analyzed for calcium. It was then placed in a series of test-tubes. Each test-tube, containing about 10 cc. of saliva and 0.1 gm. of powdered human enamel, was stoppered with cotton and sterilized by heat. Each tube was also inoculated with a known quantity of pure-strain organisms which had been isolated from the mouth. The saliva in the tube was mixed, a bacteria count made and the tube sealed and shaken at body temperature for eighteen hours. Each tube was then removed, and a bacteria count and a chemical analysis for calcium were made. From the data gathered in this experiment, we can tell the effect of each pure strain organism and any mixtures of organisms. The results of eleven pure strain and three mixed organisms are found in Table 5. Additional work is being done on the pure strain as organisms are being isolated. More work is also being done on the mixtures.

TABLE 4.—BACTERIAL COUNT AND CALCIUM DETERMINATION

Age	Sex	Cavities	Fillings	Mg. Calcium-100 Cc.		B. Acidophilus		Yeast	
				Before	After	Before	After	Before	After
VII Immune									
7	M	0	0	7.3	7.2	5,000	16,000	2,000	7,000
25	F	0	0	7.4	7.8	0	0	0	0
26	M	0	0	5.6	6.0	1,000	3,000	0	0
26	F	0	0	7.3	7.0	1,000	1,000	28,000	1,000
22	F	0	2	6.8	6.4	1,000	2,000	0	0
27	M	0	0	7.4	4.0	2,000	0	0	0
20	M	2	1	6.8	6.8	6,000	7,000	16,000	21,000
45	M	0	0	7.4	6.7	1,000	0	0	0
26	M	0	0	6.0	6.0	24,000	5,000	28,000	8,000
21	M	0	0	6.4	6.6	4,000	1,000	1,000	0
VIII Susceptible									
13	F	30	10	5.4	18.5	96,000	208,000	224,000	208,000
12	F	11	0	5.8	11.0	132,000	336,000	368,000	128,000
25	M	27	1	4.9	26.5	5,000	13,000	4,000	6,000
9	M	17	0	5.8	19.0	5,000	12,000	4,000	0
19	F	43	5	6.5	10.0	16,000	23,000	64,000	32,000
18	F	21	0	7.4	30.0	68,000	80,000	16,000	88,000
22	M	26	33	8.0	11.5	14,000	8,000	20,000	6,000
21	M	24	24	6.4	17.5	14,000	17,000	23,000	13,000
20	M	22	28	6.8	12.0	368,000	32,000	168,000	56,000
21	M	21	19	6.7	18.5	4,000	5,000	2,000	0

COMMENT

If dental caries is due to environmental instead of systemic conditions, it is rea-

sonable to assume that some difference can be found between the saliva of immune and that of susceptible mouths. In the past, all attempts to show a difference between the two types of saliva have been failures, with the possible exception that susceptible mouths have a predominance of *B. acidophilus*. The foregoing data indicate that saliva of all individuals contains a heat or antiseptic sensitive material which will cause the production of acid from sugar and hence will decalcify human enamel. The foregoing work also indicates that this heat or antiseptic sensitive substance is present in different concentrations in the saliva of immune and of susceptible people as determined by the rate at which enamel will be decalcified. This difference, if substantiated by enough cases, may be used as a chemical test for susceptibility to dental caries. If this test is found to be authentic, it will be a powerful agency by means of which valuable research in dental caries may be completed.

The heat or antiseptic sensitive substance found in saliva may be either bacteria or some enzyme type of matter. If the material is bacterial, we can easily determine by means of pure cultures in sterilized saliva which bacteria or groups of bacteria would be most effective in producing decalcification of enamel. On the other hand, if the process is found to be enzymic, the problem will be more difficult. However, in the last analysis, the action of bacteria is caused by the enzymes they contain or excrete.

The results obtained by the use of pure strain and mixed organisms indicate that pure-strain yeast and *B. aerogenes* produce the greatest decalcification. It is interesting to note at this point that *B. acidophilus* under the conditions used caused no decalcification.

In the mouth, we do not have pure-strain cultures, but a mixture of many organisms. This being the case, it is very likely that a symbiosis between certain organisms could be found. The results obtained with the few mixtures tried indicate that yeast and *B. acidophilus* exert

TABLE 5.—PURE CULTURES AND COMBINATIONS OF HUMAN SALIVA
IX

Organisms	Mg. Calcium-100 Cc.		No. of Organisms		Trials
	Before	After	Before	After	
Bacillus aerogenes	4.4	13.4	69,440,000	66,304,000	7
Bacillus (No. 3)	4.4	11.9	19,547,009	5,265,000	23
Bacillus subtilis	4.4	6.7	31,852,800	12,735,000	10
Lactobacillus acidophilus	4.4	5.9	5,126,442	348,675	7
Saccharomyces cerevisiae	4.4	14.3	19,320,000	16,408,000	7
Sarcina lutea	4.4	4.9	16,152,000	446,500	7
Sporothrix	4.4	4.5	1,875,180	727,511	7
Staphylococcus albus (acid)	4.4	10.3	40,960,800	48,114,600	10
Staphylococcus aureus	4.4	5.1	53,225,401	5,044,212	7
Streptothrix	4.4	4.5	2,296,443	1,428	7
Yeast "b"	4.4	14.4	154,500,000	130,886,000	6
Yeast and L. acidophilus	4.4	24.0	25,984,000	31,986,000	3
Yeast and B. aerogenes	4.4	15.1	918,400,000	795,120,000	5
B. aerogenes and L. acidophilus	4.4	13.8	884,800,000	554,400,000	4

a great influence on each other, and when the two organisms are grown together, about twice as much enamel is dissolved as when either is grown in pure culture. No symbiosis was found with any of the other organisms tried. However, there were only two other combinations tried. It may be that when the effects of all possible combinations are determined, more striking results will be obtained.

CONCLUSION

1. A difference between the saliva of caries-immune and caries-susceptible people has been found.
2. A chemical test for caries susceptibility has been suggested.
3. The action of pure-strain and mixed organisms on human enamel in a glucose medium has been determined.

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THE CAST SADDLE PARTIAL DENTURE

By OLIVER C. APPLEGATE, D.D.S., Ann Arbor, Mich.

THE cast saddle partial denture is a type of prosthodontic appliance that has been in use for many years. About 1910, F. E. Roach suggested its use in an assembled form[1]; that is, the base or saddle cast separately and subsequently attached to the retaining units.

In 1919, the cast one-piece removable bridge was introduced by Dr. Roach.[2] By his method, the retaining clasps and the base were cast simultaneously and as one unit.[3] Its use was at first limited to bridges replacing but one or two teeth. After several years of rather indifferent acceptance by the profession, this type of restoration experienced a sudden wave of popularity. The scope of application was likewise expanded to include extensive, complicated bilateral cases.

The general acceptance of this mode of construction may be ascribed to several conditions:

1. The development of new alloys of gold which in the cast form possessed greater flexibility. This physical property had been so much improved that there were many who now became willing to accept the use of the better cast alloys for retaining clasps.

2. A development of the casting investments accompanying this improvement of the alloys employed. Eventually, these materials were made capable of a total setting and thermal expansion equal to the shrinkage of gold during the process of solidifying. This was an epochal

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achievement in the casting process. Not only were more accurate individual tooth restorations possible, but also shrinkage in large prosthetic castings now became a factor which it was comparatively easy to control.

3. The introduction in dentistry of the hydrocolloidal impression compounds, which probably caused the greatest increase in the use of the cast appliance. These elastic materials have proved to be very accurate and their use has come easily within the range of average ability. Prior to their introduction, the taking of an impression of some partially edentulous mouths was indeed an undertaking. Simplification of the problem of impression taking has brought into the field of

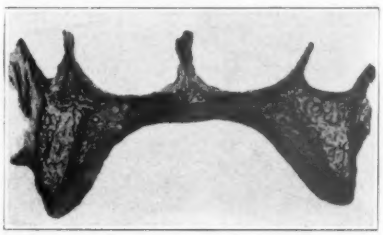

Fig. 1.—Bucco-lingual section of edentulous maxillae illustrating varying thickness of soft tissue covering. (Pendleton.)

restorative service hundreds of practitioners who before had been content to shun it as much as possible.

4. The development and expansion of the commercial laboratory. The use of this service also attracted to prosthodontics many who, for one reason or another, had been hesitant to undertake the personal construction of such appliances. With impression taking made easy by the use of the new hydrocolloids, and with the commercial technician to solve the problem of construction, a modern "gold rush" was on. It has been estimated[4] that even in a depression year—1931—about $12,000,000 worth of gold was used by dentists. A large part of this amount would necessarily have been used in the construction of cast appliances.

5. The introduction of modified methods of retention, such as the bar clasp[5] suggested by Dr. Roach. This method and others have been widely publicized commercially and have attracted many adherents.

Conservative usage of the cast saddle was emphasized by early writers who advocated it. As has been true of many another basically sound procedure, there were to be many who carried its application to extremes. In fact, its misuse has

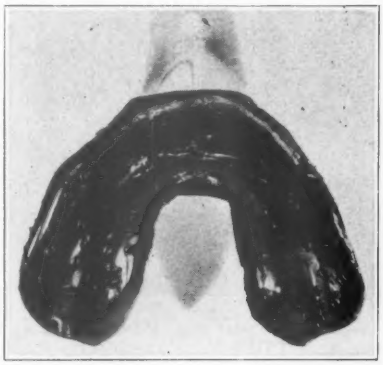

Fig. 2.—Modeling compound impression cut away in area of remaining teeth to receive hydrocolloidal material.

been flagrant, and especially is this true of so-called "extension" cases.

This type of case falls chiefly in Classes I and II, according to the very useful method of classification suggested by Edward Kennedy.[6] Under this system, cases in which bilateral edentulous areas are posterior to the remaining teeth are in Class I, and cases wherein such an edentulous area is unilateral are in Class II. Since they have no posterior abutments, these types offer the greatest difficulty in

the use of the cast base; and because of this difficulty, this discussion will be directed chiefly to their consideration. The deductions apply with equal emphasis to all restorations in which the major means of support is the residual alveolar ridge.

It has been said that the construction of a removable partial denture is one of the most difficult of dental operations. Why is this true? Perhaps we should start with a common understanding of the exact scope of a partial denture. It is a prosthetic appliance which is substituted for lost natural teeth and which derives its major support from the residual alveolar ridge and minor support from one or more teeth serving as abutments.

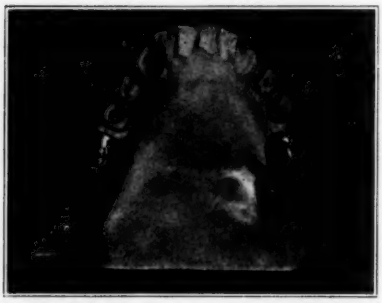

Fig. 3.—Artificial stone master model with thin metal (Ash's No. 7) adapted to saddle areas.

From this definition, we see why it is difficult to achieve uniform success in this type of replacement. Its support is of a composite nature, one end resting on a ridge covered by a pad of elastic tissue, the other end supported, at least in part, by a tooth with definite limitation of movement. The failure to coordinate properly the support from these dissimilar foundations is the basis for the majority of our difficulties.

In order to understand the problem better, let us look at the anatomic structure of the tissue subjacent to the denture base. The residual ridge is the part of the alveolar ridge remaining after the removal of the teeth. It varies in size and form according to the degree of destruction of the bone by disease prior to extraction of the teeth and the destruction resulting from necessary surgical interference.

The bone may show wide variation in its cancellous structure. One case may present a dense, hypercalcemic type, characterized by heavy trabeculae and small intertrabecular spaces. From such a ridge, under normal conditions, little resorptive change may be expected. At the other extreme is found a loose, honeycombed, hypocalcemic structure, with thin trabeculae and large intertrabecular spaces. In a ridge of this formation, a much greater degree of resorption is likely to occur and a base which may be easily corrected is indicated, such as vulcanite or one of the more modern basal intermediaries.

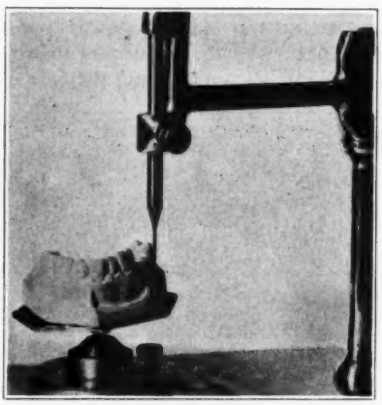

Fig. 4.—Master model mounted for study on surveyor to determine common "height of contour" of abutment teeth. Adequate clasp retention may thus be assured and excessive retention avoided.

A like variation of the cortical layer is

also found, it being thick and heavy in some places and thin or even missing in others. Less frequently, there may exist a condition of diffuse bone atrophy.[7] Such a disturbance may accompany a systemic disease such as diabetes, a glandular disorder or a metabolic disturbance. It is a rapidly resorptive process which may be greatly accelerated by the imposition of a functional load. Such a condition contraindicates the use of a cast base, if indeed the use of any type is possible.

Covering this bony foundation is a pad of fibrous connective tissue varying in thickness and contour. Interspersed are fatty deposits, mucous glands, large vessels and nerve trunks. Thus we find a

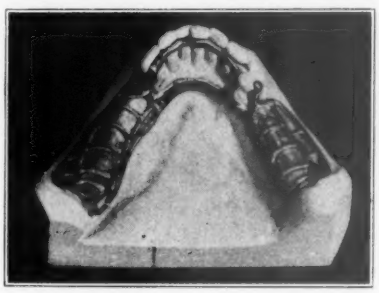

Fig. 5.—Casting seated on master model over metal bases. (Compare Figure 3.) The cast network in the saddle areas is to be noted.

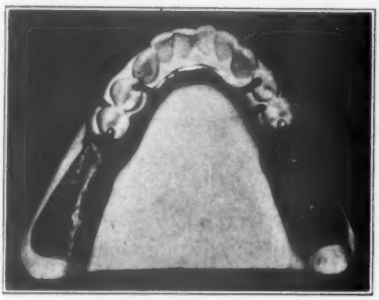

Fig. 6.—Casting attached with sticky wax to metal base (left side); wax bite-rim added over metal base and casting on right side.

covering of subjacent tissue varying to a considerable degree in compressibility or displaceability. When pressure is applied, some areas are found to yield only a little, while others are noticeably compressed. E. C. Pendleton[8] has made a valuable contribution to the study of the human edentulous jaws. His fine cross-sections depict with clarity the tissue variations to be encountered. (Fig. 1.)

The residual ridge may be said to possess two distinct forms: (1) the anatomic, which is the surface contour of the tissue in a state of repose, and (2) the functional, which is the tissue contour when stress is applied thereto, resulting in a partial displacement. It is readily seen that this functional form will depend on the amount of load applied and on the character of tissue structure.

This brings us to a consideration of the problem of impression taking, which is unique in partial denture prosthesis.

In the first place, in order to achieve a perfect fit of that portion of the appliance engaging the teeth, an impression must have extreme accuracy and be preferably in one piece. For this purpose, the material *par excellence* is hydrocolloid. Its accuracy is certain; it is easily manipulated, and it is, by far, of the several materials available the most pleasant to use. Plaster is still the choice of many, but its use is more unpleasant to the patient and requires much more time and it must be reassembled. Waxes and compounds are not sufficiently accurate, and are particularly undependable where there are badly malposed teeth.

Secondly, in order to achieve a registration of the functional form of the subjacent tissues, an impression material is required which will effect partial displacement in the softer areas. It is evi-

dent at once that a hydrocolloid or plaster, both semifluid, is not satisfactory for this purpose, because with neither can any pressure be exerted. Therefore, the impression material that is ideal for the registration of tooth surfaces and correct interrelation of the teeth will register only the surface or anatomic form of the ridge. Conversely, the material that will register functional ridge form is useless when an accurate record of tooth form or relationship is desired.

At the present time, by far the larger number of cast prosthetic appliances are made from hydrocolloid impressions. This means that in a restoration so made the cast base will fit the surface contour of the residual ridge.

Fig. 7.—The casting reseated on the cutaway master model and supporting the wax impression of the residual ridges in proper relation to the teeth.

Now let us analyze the result: Stresses applied to this base will be borne only by the areas of denser structure. If the area of firm tissue is small in comparison to the total area covered, the result will be surface irritation in spots as a result of overstimulation. Continued repetition of this causes inflammation, and Nature, in an effort to inhibit this process, brings about tissue resorption. Other areas of the ridge now assume the load and in turn are irritated and resorbed. The result of this resorptive process may be complete loss of support and the consequent depression of the base when stress is applied, throwing leverage on the abutment teeth. The ultimate effect of such leverage is well known to every one with clinical experience, particularly the exodontist and parodontist.

If when a saddle is cast to fit surface contour, only the more dense tissue can absorb the load, why should the saddle be extended to cover the compressible areas? Such a procedure would seem to be devoid of purpose and, furthermore, of questionable advisability. The ridge tissue receives more or less constant stimulation by massage from excursions of food or tongue and cheek contact during mastication and other activity. When covered, it is denied stimulation from these sources and will receive none unless the base is transmitting to all areas alike an intermittent flow of pressure stimuli. Just to the degree that this is accomplished will the desired vasomotor action of the nutrient vessels result.

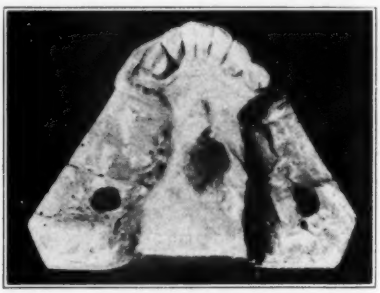

Fig. 8.—Residual ridge areas of master model cut away.

The effect of coverage, without actual stress application, is analogous to disuse atrophy observed in other tissues that are not in function. Stasis, or stagnation of the blood supply, produces an unhealthy

tissue tone, which may progress to actual resorption. Chayes[9] pointed out many years ago the need of physiologic stimulation from restorative bases, and the astuteness of this observation has become more and more apparent.

Therefore, from uneven distribution of the functional load, we find three processes working: (1) overstimulation of the limited, harder areas from too much work; (2) understimulation of the softer areas from too little or no work at all, and (3) destructive leverage applied to the abutment teeth as a result of the resorption following these two conditions.

This is the picture seen daily in clinical practice and resulting from improper impression registration.

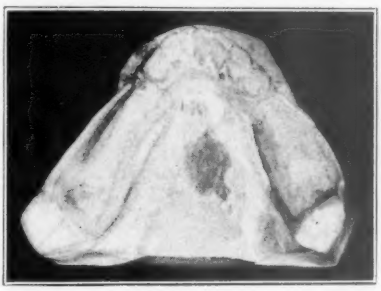

Fig. 9.—Master model with residual ridges of correct contour (functional) as obtained from fluid-wax impressions under actual functional stress.

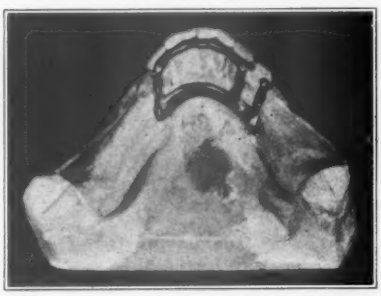

Fig. 10.—Temporary gold network removed from casting. Only the major (lingual bar) and minor (vertical arm) connectors, the indirect retainer (continuous clasp) and direct retainers (clasps) are kept.

In an effort to correct this defective procedure, many operators have sought to combine plaster or the hydrocolloid material with wax or compound. The latter is used for an impression of ridge areas and is cut away in the region of the remaining teeth. (Fig. 2.) Hydrocolloidal or plaster is now added to the impression, which is returned to the mouth and reseated under pressure. The intention is to partially displace the soft tissues, and, with them in this condition, to register in correct relation the remaining natural teeth. This would seem an ideal solution. On study, it appears to have definite weak points:

1. We cannot be certain that the soft tissues were correctly displaced with the original compound or wax impression. If the material was too hard, overdisplacement resulted; if too soft, insufficient displacement.

2. It is almost impossible to reseat this compound or wax impression in exactly the original position.

3. It is extremely difficult to obtain exactly the degree of pressure that was applied the first time.

4. We have no assurance that the pressure applied is the same that will be exerted during function.

5. Neither do we know that the direction of this force is comparable to that which will obtain during mastication.

6. Since this is an open-mouth technic, the force must be applied by finger pressure, and no operator can maintain a force comparable to that exerted during function for a sufficient length of time to allow the fluid impression materials to harden.

While the result obtained in this manner may be an improvement, it is still far short of perfection.

Attacking the problem from a different angle, I have, since 1923, resorted to a "rebasing" technic, employing various waxes. This method, of course, has been limited to bases constructed of vulcanite, or some other material to which a lining could be added. Dr. Nesbett has suggested the use of carding wax and later paraffin in some such manner as this.

Dr. Kennedy, in a discussion of rebasing,[10] also dwells rather at length on the merits of this method of registration to procure balanced stress distribution throughout the saddle area.

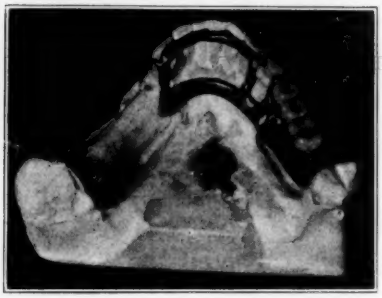

Fig. 11.—One gold saddle cast and seated on master model ready for assembly to major and minor connectors (lingual and vertical bars).

An impression of the residual ridge tissues should be made under actual working conditions. We should be interested in restoring function; hence, the balance and stability of the base should be most dependable during function. How can we hope for this if saddles are made to fit the tissues as found in a state of rest? Here, the best tissue saddle relation would obtain during periods of nonuse and the most unstable during periods of function. This seems the converse of logic.

The difficulty of employing a rebasing technic with the gold saddle has caused many cautious practitioners to limit its use to those ideal ridges having a uniformly firm tissue tone. They recognize the many advantages of the gold base, but are willing to forego these in the interest of greater permanency. In doing so, they are attempting to render a service which M. M. DeVan[11] has so admirably defined in the following words: "To strive for the perpetual preservation of what remains rather than the meticulous restoration of what is missing." This should become the motto of every one rendering partial denture service.

I have achieved the most satisfactory

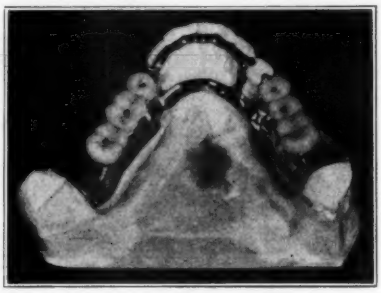

Fig. 12.—Finished partial denture.

results, over a period of nearly fifteen years, by the use of fluid waxes in the rebasing technic referred to previously. Various attempts have been made from time to time to incorporate this method in the construction of a cast saddle. This has finally been accomplished. It now would seem that the use of the cast base may be safely extended to include many less satisfactory ridge formations where formerly only composition bases were considered safe by conservative operators.

Before describing this new technic, I shall mention a few of the advantages of using materials commonly called "fluid waxes":

1. Since they are fluid, their application is easily accomplished.

2. Such an impression is readily corrected; that is, more wax may be added to a limited area which does not show the desired registration.

3. By use of a wax having a determined rate of flow, sufficient displacement of tissue may be achieved without the danger of overdisplacement.

4. Such an impression permits use of the closed-mouth technic, in which the patient applies pressure by biting in centric relation. This pressure will be the same as that applied in function, and can be maintained in a uniform degree for an indefinite length of time. It is also applied in the same direction as in normal functional activity.

5. The nature of these waxes is such that there is a differential appearance between those areas which are receiving support from the tissue, and those not receiving such support. The former condition will give a glossy appearance to the wax; in the latter instance, the surface will remain dull.

With these waxes, an impression is obtained which is a true registration of functional ridge form, that contour assumed by these tissues when definitely resisting stresses applied to the base. A base constructed from such an impression, on receiving stress, transmits and distributes the load in accordance with the ability of the tissues to support it. When stress is applied, the fluid content of the subjacent tissues will be slightly displaced. After the load is released, a slight tissue rebound occurs. Increase in blood flow results, bringing a more adequate nutritive supply to the tissue cells. This physiologic stimulation maintains a healthy condition and counteracts resorptive processes. Since the load will be uniformly distributed, overstimulation or irritation is avoided. The result is a ridge that is maintained indefinitely, with the minimum of atrophic change.

The exceptions to this statement are those cases in which acute or chronic bone resorption is occurring as a result of general systemic disorder, dietary deficiency, endocrine disturbances, senility, etc. Such conditions should receive the treatment indicated before an attempt is made to replace lost teeth. This is but an instance of the wisdom of making a careful preliminary survey, in order to determine exactly the conditions with which one must cope. When periodic rebasing is foreseen as a necessity, the use of a cast base is usually unwise, but the technic now to be described makes later corrections easily possible without the necessity of a complete reconstruction. It is not limited to any one method of retention, but is adaptable to all.

The first step in the construction of any partial denture, regardless of type, should be a complete roentgenographic examination. This should not be limited to the remaining teeth, but should include the edentulous areas. It is essential that we know the type of supporting tissues which are to act as the foundation. The presence of remaining roots, unerupted teeth, foreign bodies, cysts, etc., in edentulous spaces, is extremely common. Therefore, it is advisable to take nothing for granted, regardless of the fact that the mucosa may present a normal appearance.

Study models made from accurate impressions are essential to a correct diagnosis. Frequently, operators will take wax or compound impressions for the construction of study models. The value of these is practically nil. One of the more important uses of study models is to determine the possibilities of retention when clasps are to be utilized. Unless we have accurate reproduction of tooth contour, it is impossible to determine whether the teeth to be used as abutments offer suf-

ficient retentive possibilities. Study of occlusal relations also requires accuracy of tooth form. Therefore, the use of a hydrocolloid or plaster as an impression material is imperative.

With the data available from study of the roentgenograms and models, it is now possible to determine the necessary steps in the preparation of the mouth. This would include any necessary surgical procedure, such as extractions, removal of hypertrophic tissue and areas of infection and, frequently, reduction or reshaping of the bony ridge. Many operative procedures are indicated and should be performed next, in order to have the remaining teeth in the best possible condition. This would include any necessary changes in the abutment teeth in order to provide for the type of retention which has been selected for the case in hand. Occasionally, it is feasible to resort to orthodontic measures for the correction of malposition, extrusion or malalinement of the remaining teeth. After a thorough prophylactic treatment, the mouth is ready for the final impression.

As has been pointed out, since we are primarily interested at this stage in accurately registering tooth form and interrelationship of the abutment teeth, the impression material of choice is again a hydrocolloid. Another use of the study models should be mentioned at this point. Having examined the casts for retention, we now examine the impression for defects in those areas essential to the construction of the appliance. Should an imperfection occur in an area which is not essential, it is not necessary to discard the impression.

After a satisfactory result is obtained, the impression is poured in artificial stone, preferably of the rapid-setting variety, and is studied for imperfections. If it is found to be acceptable, the next step is to outline the saddle areas. To these surfaces, a thin metal is burnished. (Fig. 3.) The model is then placed on a surveying instrument for the determination of the most acceptable path of insertion and removal of the appliance. From a study of the relationship of the abutment teeth, we can determine the location of the clasps, so that sufficient retention will result, but locking interference will be avoided. (Fig. 4.)

A common mistake, when clasps are used, is that too much retention is obtained. There should be just a sufficient degree to overcome any tendency to displacement from muscular movement, from the pull of sticky food or from the effect of gravity. An appliance should not be held too rigidly in place, regardless of the mode of retention. It should be able to move with the tissue which supports it, but should not move upon this tissue. Neither should abutment teeth be subjected to strain during removal or insertion, and this can be definitely avoided if a surveying instrument has been used in determining the common height of contour of the abutment teeth.

The stone model, with the metal bases in place, is now duplicated, either scrap hydrocolloid or other materials that are available for this purpose being used. The casting model is made of an investment capable of a total expansion equal to the contraction of gold (1.25 per cent). Upon this model, we will find a raised saddle area, resulting from the impression of the metal bases. The advantage of this feature is that we may now adapt the wax pattern directly to the raised surface. The finished casting will then stand away from the tissues, a sufficient space for impression waxes to be used later being thus provided. Waxing of the pattern is completed according to the predetermined design. In the saddle area, a light network is added to the usual pattern, the purpose of which will become

apparent in subsequent steps. This is now cast in the customary manner, properly finished and returned to the master model for any necessary adjustments. (Fig. 5.) Wrought clasp arms, if they are to be utilized, may be soldered to the casting at this time. The framework is now taken to the mouth and checked for accuracy. Any occlusal interference is eliminated so that the patient can close comfortably in the desired centric relation.

The outer surface of the metal bases is roughened with a coarse heatless stone and coated with sticky wax. The framework is slightly heated, and quickly seated on the model with the metal bases in place. The warm gold will become embedded in the sticky wax. More wax may then be added to insure firm attachment. Bite-rims of wax are now placed over the framework and metal bases and securely attached thereto. (Fig. 6.) With a hot spatula, the bite-rim is softened to considerable depth. It is carried to the mouth and centric relation is obtained. Transfer is now made to the articulator of choice, and the models are occluded and mounted to the instrument. The wax bite-rims may now be removed, modeling compound ones being placed in their stead. These are returned to the mouth and the relation is checked. If this is found to be correct, the patient is allowed to wear this temporary structure for a few hours, frequently overnight. He is instructed not to attempt to masticate, but is asked to close frequently in firm biting pressure.

On the patient's return, the operator must make sure that there is no interference on closing to centric position. The metal bases are carefully removed from the under surface of the compound bite-rim, and impression wax is added. One of the fluid waxes now available on the market is preferred for this purpose. Carding wax, while soft, does not have sufficient flow, and because of this sluggish quality, it has been found unsatisfactory. Paraffin, recommended by some, has a tendency to crumble and flake. These special waxes must be melted in a double boiler because of the danger of volatilizing some of the ingredients if dry heat is used. The wax is painted on the under surface of the saddle structure with a fine brush, occupying the space made available by the removal of the metal base.

The entire saddle is covered and is placed in the mouth, and the patient is asked to close under firm pressure. After one or two minutes, the saddle is removed and dried with compressed air. In the areas where the tissue does not offer definite support, the surface will be dull; elsewhere, it will be glossy. To the dull areas, more wax is added, the process being repeated until the entire surface has a glossy appearance.

To be sure that no tissues have been overdisplaced, the saddle is allowed to remain in the mouth under functional stress for several minutes, during which time the usual muscle trimming is accomplished. The length of time allowed, the stress applied being constant, will depend on (1) the rate of flow of the wax used; (2) the temperature at the time of insertion, and (3) the amount of excess wax that has been added. The advantage of using a wax with the definite rate of flow which has been found best suited to clinical needs should be apparent. It is surprising how widely two different quantities of wax may vary, although obtained from the same commercial source. Not only is this true of flow, but of other physical properties as well. Therefore, the advantage of having tested material is not to be underestimated.

The finished impression is carefully removed to prevent distortion, and is placed in cool water pending the next step in the procedure. By the use of such an

impression method, these advantages have been gained:

1. Uniform support has been obtained from the variable tissue areas.

2. The wax used, because of correct flow, has provided for sufficient tissue release to assure that no overdisplacement has occurred.

3. The support from the residual ridge has been correctly coordinated with the support from the abutment teeth.

4. The impression is in correct relation and firmly attached to the remainder of the appliance.

With carborundum disks or small saws, where possible, the ridge area of the master cast is generously cut away so that the framework carrying the new impression may be seated in place accurately. (Fig.7.)

The cast is saturated and a mix of stone is carefully packed in the impression. When hardening has taken place, the appliance is removed. We now have a cast the ridge of which conforms to functional contour, and this in exact relation to the remaining teeth. (Fig. 8.) The biteblock is detached from the appliance and the framework of the edentulous area is cut off. (Fig. 9.)

Those who wish to wax directly to a cast model may do so by duplicating the new master cast and producing one of casting investment. Twenty-eight gage wax is adapted in the usual manner to form the pattern for the saddle. This should be thickened around the periphery to insure greater comfort to the tissues. Tube teeth are adjusted as to occlusion, adapted to the ridge and waxed in the usual manner. The sprues are then attached and the wax pattern is invested.

The saddle, after being cast and finished, is returned to the master cast and checked for adaptation. (Fig. 10.) With a splint of plaster, the saddle and the remainder of the appliance may be removed from the cast, invested and united by solder. It is now placed in the mouth and checked for accuracy of saddle relationship. If satisfactory, the porcelain teeth are added singly and adjusted to a balanced occlusion. (Fig. 11.)

Heat treatment of modern alloys is essential in order to gain full advantage of their physical properties. This is accomplished in the following manner: First, the appliance is embedded in casting or soldering investment so that the outer surface is exposed. It is then heated, preferably in an oven, to a dull red (1450° F.) and quickly quenched. This gives the gold throughout the structure a uniform molecular arrangement. It is again heated, in either a salt bath or an oven, to the temperature and for the period of time specified by the manufacturer as best suited to that particular alloy. The final finishing and polishing complete the construction. We now have an appliance in which the cast saddle has the desirable relationship to the subjacent tissues that heretofore has been limited to those restorations in which a rebasing technic was possible. It has the further decided advantage of being easily corrected in those cases wherein resorption follows insertion.

This is accomplished by taking a wax impression in the saddle exactly as was done in the original construction. The master casts of all such cases should have been filed away. We need only cut away the ridge areas and return the appliance to the cast, repouring the section included in the new impression. The porcelain teeth are then removed from the appliance by heating in acid; the saddle is untacked at the solder joint, and a new wax pattern is constructed. This is then cast and reunited. The portions of a partial denture requiring the greatest amount of time in construction include the retention units and the various connectors uniting these units. In making a correction

following this method, we need not disturb any of these units and so the recasting and reassembling of the saddle require the least possible time. With a precise and comparatively easy technic available for readjusting the cast saddle where resorption has occurred, the scope of its use can with safety be greatly widened.

CONCLUSIONS

1. The tissues of the residual ridge vary greatly in thickness, contour and displaceability.

2. The residual ridge has two distinct forms: first, surface or anatomic contour; second, functional or compressed contour.

3. Plaster or hydrocolloids are excellent for registration of the remaining teeth, but are incapable of the desired registration of the tissues subjacent to the saddle.

4. An impression material capable of displacing effectively the more elastic tissues of the edentulous area is essential.

5. Waxes, while ideal for this purpose, are not sufficiently accurate for registration of the teeth.

6. Impression registration of the functional ridge form should be accomplished by the same amount and direction of stress to be encountered in actual usage.

7. The most satisfactory way to accomplish this is by the closed-mouth technic employing the various waxes as impression materials.

8. The cast saddle, as made from plaster or hydrocolloid, does not uniformly distribute the stress to the subjacent tissues.

9. As ordinarily constructed, the cast saddle does not lend itself readily to rebasing.

10. Cast bases have been indiscriminately employed even where unstable ridge tissues existed.

11. If the technic of construction here suggested is followed, the cast saddle partial denture can be made to distribute the functional load uniformly: first, throughout the entire area of subjacent tissue; secondly, between the residual ridge and the abutment teeth.

12. Appliances so constructed and so maintained will function efficiently and, more important still, will contribute to the preservation of the tissues.

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CHANGES OF MATERIALS AND THE TECHNIC OF CASTING WITH REGARD TO ACCURATE COMPENSATION

By MAURICE A. GOLDBERG, D.D.S., Washington, D. C.

THIS work was undertaken at the Georgetown University Dental School for the benefit of the various departments concerned with casting, to determine the value of the various materials on the market today with regard to precision casting and as a guide in purchasing. I am indebted to J. J. Kelly, my associate in the department of dental materials, for his aid in some of the determinations made.

Dental literature, for several years past, has had many pages devoted to explanations of casting processes and of investigations on the materials used. Research, especially that done at the U. S. Bureau of Standards by the American Dental Association Research Commission, which has set up specifications for the various materials, has inevitably led to improvements in both materials and technics. We are indebted to such men as W. A. Price, C. S. Van Horn, D. W. Phillips, C. H. Scheu, R. H. Volland, R. L. Coleman,* N. O. Taylor, G. C. Paffenbarger and W. T. Sweeney, and a host of others, for a wealth of knowledge concerning the methods of producing proper castings and the physical properties of the materials involved. These scientists and investigators have worked out the theories and the practical applications of precision casting.

We are cognizant of two distinct changes in the materials which are used prior to casting: expansion and contraction, which, we are told, will counterbalance each other, provided definite materials are used and in a definite manner. It is unfortunate that, in practice, some of the exact features of these definite technics are not followed. This is due to many conditions, outstanding of which is the time element. Many men in practice are not able, owing to lack of time, to carry through consistently at each operation a definite casting technic which will assure them ultimate success. They fall, therefore, into a modified technic of their own. This practical application becomes a yardstick by which is measured the success of a technic or material in the eyes of the practitioner.

Our definite knowledge of the extent of these changes is limited, in the main, to the advertising matter of the manufacturers. Claims are made of definite expansion of investments and waxes when used in connection with definite procedures. Many of these claims fall far short in practical use, because, for one thing, the suggested technic is not followed. The problem, therefore, which confronts us is just what these materials will do when they are used in the same manner as in private practice. In other words, what happens when these materials are treated, not by the technic suggested, but by the "practical technic," as we may term it.

With this in mind, an investigation was

*COLEMAN, R. L.: "Physical Properties of Dental Materials." U. S. Bureau of Standards Research Paper No. 32.

made of the technic used in the offices of twenty-one practitioners in this community, by talking with and actually observing them as they proceeded to produce castings. Every step was checked and recorded. A more or less standardized technic was discovered, which is employed in the work to follow.

CONSIDERATIONS

There are two changes which occur in the materials, expansion and contraction. Expansion occurs in the investment during both setting and heating. Contraction occurs in the wax, the gold and the investment. The wax pattern is obtained by two methods, direct and indirect. In

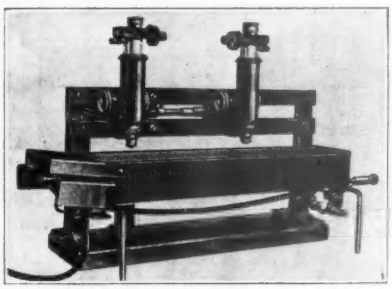

Fig. 1.—Trough containing electrically controlled water bath and attached to comparator microscope apparatus.

the former, the wax is heated and softened and applied directly to the tooth cavity. In the latter, the wax is applied to a metal model of the tooth and the prepared cavity. Good operative practice teaches us to return the model-produced pattern to the tooth cavity for accurate fitting and carving. During the securing of the pattern, whether by the direct or the indirect method, the wax assumes mouth temperature, regardless of whether it has been introduced into the mouth hot or cold. When it is removed and left in the open air, it assumes room temperature. Here, then, is a definite shrinkage due to a difference in temperature between the mouth and the room.

The average net shrinkage of gold is 1.25 per cent.[1]

The shrinkage mentioned above, in the investment, is not essentially shrinkage. It is rather a loss of expansion. We are

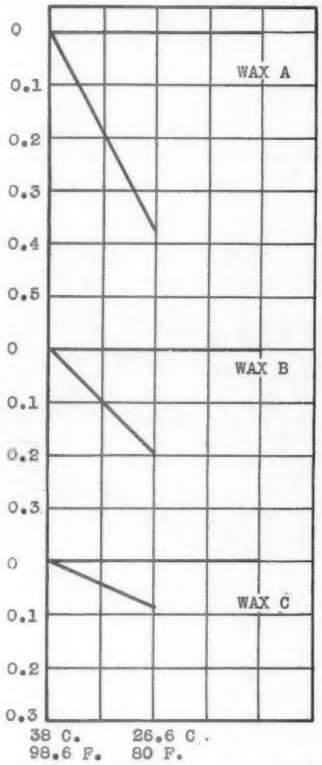

Fig. 2.—Contraction of inlay casting wax from mouth to room temperature. Left, percentages of contraction. Below, temperatures.

told that at the maximum casting temperature, the various investments will have attained a certain expansion. Casting is not done at the maximum casting temperature. If it were possible to cast

directly in the furnace, advantage would be taken of the maximum expansion obtained at that temperature. The crucible is removed from the heat and, prior to casting, is allowed to cool more or less, according to the technic employed. There is a drop in temperature, and a corresponding loss of expansion which must be taken into account.

"PRACTICAL TECHNIC"

In seventeen of the twenty-one cases, the wax pattern was produced by the direct method. The wax was heated over an open flame until it was sufficiently plastic for use. It was then pressed into

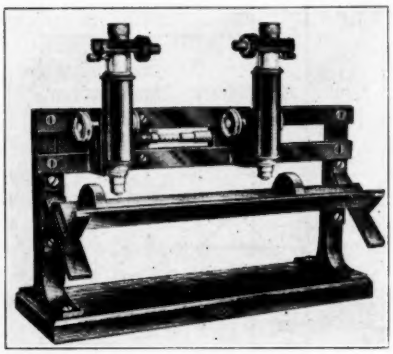

Fig. 3.—Trough under two comparator microscopes in which investment material was tested.

the tooth cavity, carved and burnished. The time consumed in the operation varied with the size and accessibility of the cavity. In no case was it less than twelve minutes. In four cases, wax patterns were first prepared on an amalgam die and then returned to the tooth cavity for final carving and burnishing. A sprue wire was then imbedded in the wax, which was then removed. Only two men were able to proceed immediately with the investment of the pattern, and then only after lapses of nine and ten minutes,

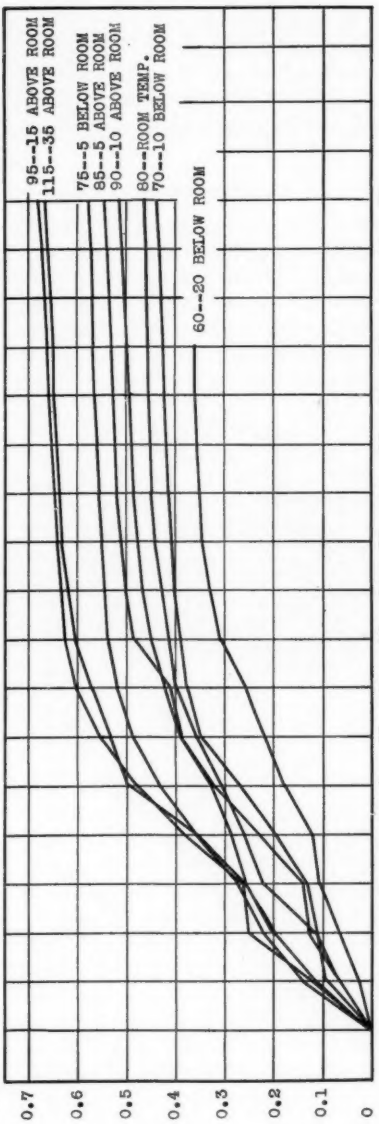

Fig. 4.—Setting expansion of A inlays (water:powder, automatic scale) (Sept. 10, 1936). Left, percentages of expansion. Below, time in minutes.

respectively, while the patient was being dismissed. The remaining nineteen placed the pattern in a dish of water to await an opportunity for investing. On an average, between two and three hours elapsed before the operation was continued. In one case, the pattern remained in the dish for two days. Three kinds of wax were used, green, blue and purple.

In most cases, the investment process is entirely hit-or-miss. In only seven cases were the water and powder carefully weighed out and the manufacturer's instructions carefully followed. In these

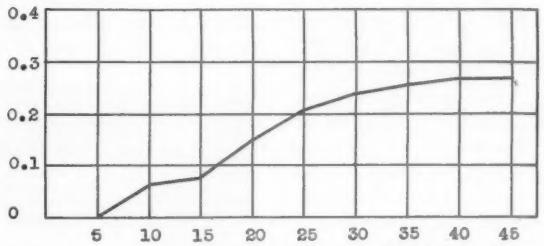

Fig. 5.—Average setting expansion of B model investment each five minutes (water, 30 cc., powder, 100 gm. [3.5 ounces] [0.267 per cent]). (Sept. 28, 1936.) Left, percentages of expansion. Below, time in minutes.

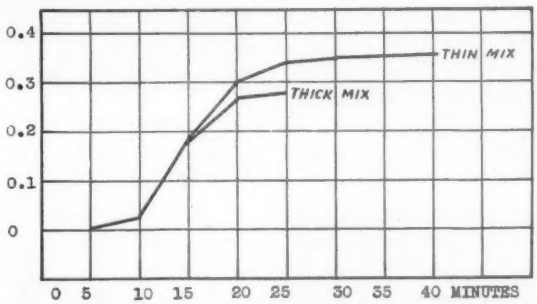

Fig. 6.—Average setting expansion of C investment each five minutes (water:powder, thick mix: 26:100 by weight; thin mix: 35:100 by weight). (Sept. 16, 1936.)

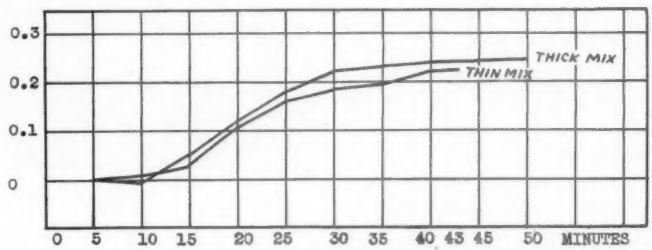

Fig. 7.—Average setting expansion of D investment each five minutes (water:powder, thick mix: 27:100 parts by weight; thin mix: 31:100 parts by weight).

cases, this was done because the manufacturer of the investment material used furnishes a weighing apparatus. Otherwise, the proportions were estimated. Four types of popularly known investment materials were used. In all but one case, mechanical spatulation of one type or other was used. Here again, the next step in the procedure awaited the convenience of the operator. Most of the men allowed the investment to stand overnight and cast the following morning.

Twelve men carried on the eliminating process by means of electric furnaces, the remaining nine using gas eliminators.

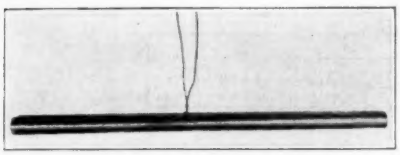

Fig. 8.—Investment specimen (200 mm.) made in mold shown in Figures 9-10.

Fig. 9.—Mold in which investment specimen was made (Fig. 8).

The electric furnaces ranged from a very simple to a very elaborate type. All were capable of reaching 1400 F. The gas eliminators ranged from a simple Bunsen burner to a type which produced heat all around the crucible. Elimination was carried on usually between one and two hours. Two operators, using electric furnaces, allowed the crucible to soak for two hours at a low heat, previously to turning on the high heat.

In thirteen cases, casting was carried on with air-pressure machines, all fairly uniform in design; in seven, centrifugal casting machines were used, and in one, a pressure machine without air was used. The procedures of this group immediately prior to casting fall into classes based on the type of casting machine used. The men using air pressure all removed the crucible from the heat and placed it on

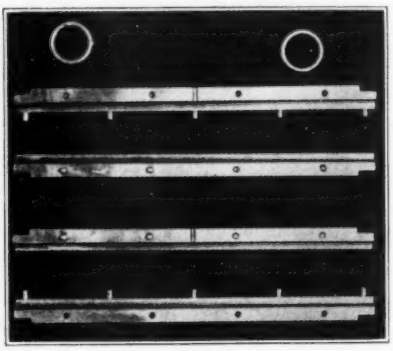

Fig. 10.—Details of mold (Fig. 9).

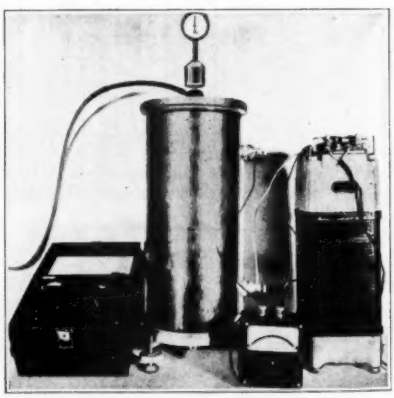

Fig. 11.—Thermal expansion apparatus.

the casting machine. They lighted the blow torch, which in all cases is a mixture of gas and compressed air, applied the heat to the ring for a short period of time, melted the gold and then cast. The movements of those employing the cen-

trifugal machine differed in that they did not heat the ring previous to casting. Two reasons were given for this: They wished to avoid disfiguring a nicely chrome-plated apparatus; and only a small portion of the ring could be heated because of the manner in which it is retained in the machine. By actual check with a watch, the time consumed in the movements between removal of the crucible from the heat and the moment of entrance of the gold into the mold averaged two minutes.

The "practical technic" followed in this work was taken from the foregoing description of the actual technic used in dental offices. The wax was tested for shrinkage from mouth to room temperature, 80 F. being taken as room temperature throughout. The investment was measured according to the directions given by the manufacturer, because it was not possible to estimate the amounts of powder and water used in each case. The results would obviously not be the same during each test of the same material un-

Range of Thermal Expansion and Shrinkage

Material	Type	Temperature Degrees (F.)	Expansion Phase				Shrinkage Phase* of Wax Mouth to Room Temperature
			Setting Expansion		Thermal Per Cent	Total Per Cent	
			Per Cent	Time Minutes			
Wax	A						0.376
	B						0.0196
	C						0.0085
Investment	A	60	0.3595	70	1.225	1.5845	
		70	0.439	90	1.186	1.625	
		75	0.575	90	0.990	1.565	
		80	0.460	90	1.035	1.495	
		85	0.547	90	0.983	1.530	
		90	0.512	90	0.920	1.432	
		95	0.682	90	0.818	1.500	
		115	0.673	90	0.471	1.154	
	B	Proportions Water/Powder 30 cc./100 parts	0.267	45	0.907	1.174	
	C	Thick mix 26/100 pts. weight	0.277	25	0.885	1.165	
		Thin mix 35/100 pts. weight	0.353	40	0.657	1.010	
	D	Thick mix 27/100 pts. weight	0.245	50	0.742	0.987	
		Thin mix 31/100 pts. weight	0.288	43	0.812	1.100	

*Shrinkage from loss of heat on removal was for all investments 0.034 per cent; for the gold, 1.25; total (less wax shrinkage), 1.284.

less the proportions were the same. Investment specimens were allowed to stand overnight previous to testing for thermal expansion; which was carried on for one and one half hours, because the furnace used reached its maximum temperature in that time and that was the average time allowed by the practitioners for least. In certain cases, as many as ten tests were performed to strike an average.

TESTING WAX

Wax rods were placed in a trough in an electrically controlled water bath attached to a comparator microscope apparatus (Fig. 1). The water was raised to

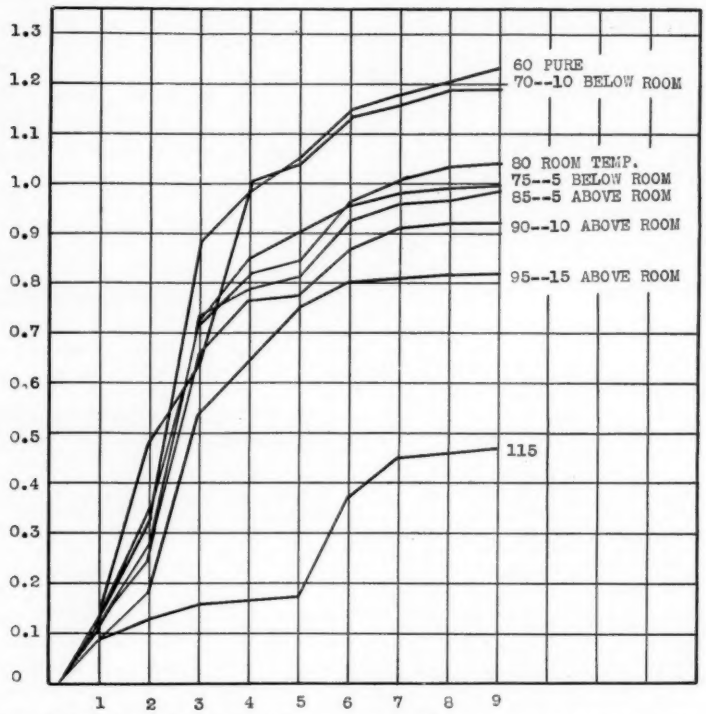

Fig. 12.—Thermal expansion of A inlays (water:powder, automatic scale). Left, percentages of expansion. Below, degrees centigrade times 100. (Sept. 10, 1936.)

burning out. The furnace used was a large muffle type capable of reaching 1400 F. in ninety minutes. Casting was done by means of a standard air-pressure machine. It was not possible to use a centrifugal type in these determinations. Every test was performed in triplicate, at slightly below mouth temperature, 98 F., and left at that temperature for thirty minutes, being stirred constantly. After a reading was taken, the water temperature was dropped to that of the room and allowed to remain so for thirty minutes, and again constantly stirred, and a read-

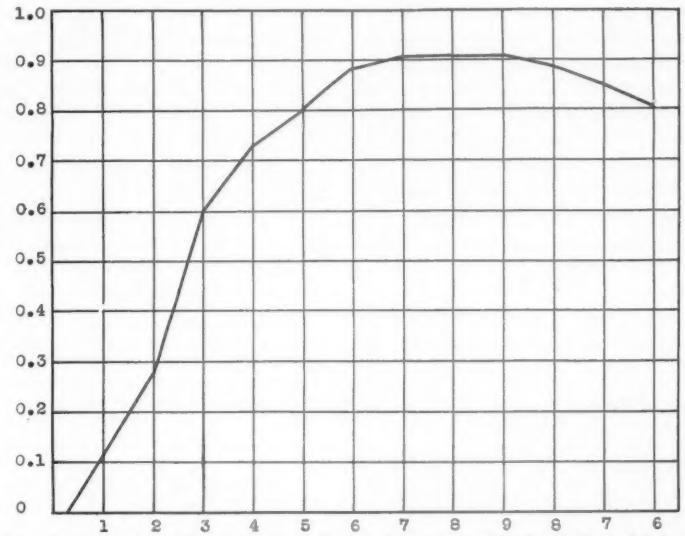

Fig. 13.—Average thermal expansion each 100 degrees centigrade of B model investment (water:powder, 30:100 parts by weight). Left, percentages of expansion. Below, degrees centigrade times 100. (Oct. 9, 1936.)

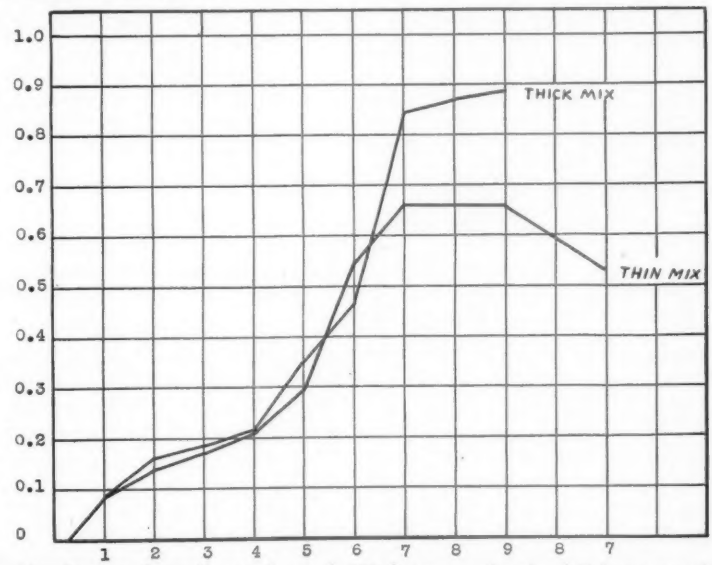

Fig. 14.—Average thermal expansion each 100 degrees centigrade of C investment (water: powder, thin mix: 35:100 parts by weight; thick mix: 26:100 parts by weight. Left, percentages of expansion. Below, degrees centigrade times 100. (Oct. 7, 1936.)

ing taken. From these data, the percentage of contraction was computed. The accompanying table shows the results of these tests. It will be seen that wax A showed a contraction of 0.376 per cent; wax B showed only a fraction of that amount of contraction, 0.0196 per cent, and wax C, with a contraction of 0.0085 per cent, only less than half that of wax B (Fig. 2).

INVESTMENT

There are two dimensional changes occurring in the investment material. One is the expansion on setting of the material; the other, the expansion on heating. The setting expansion was tested by mixing the material with water in the proportions proposed by the manufacturer. This was then run into a trough under two comparator microscopes focused on reference lines (Fig. 3). Readings were taken periodically, and the expansion in percentage of the original length was computed. In only one case was the setting expansion found to be exactly the same as is stated by the manufacturer. The time consumed for the maximum expansion varies from twenty-five to ninety minutes.

In a few cases, there was a very slight rise in twenty-four hours. Figures 4-7 show the average setting expansion at five-minute intervals. Investment A (Fig. 4) afforded some surprises. This material is used in connection with another material supposed to have an effect on thermal expansion. A weighing apparatus which is based upon the room temperature is furnished by the manufacturer. Thus, in mixing the two materials, with room temperature as a basis, the higher the temperature, the greater the amount of the above-mentioned powder included in the mix, and the lower, it is asserted, the thermal expansion. Also, according to the manufacturer, this follows in consecutive order. No mention is made

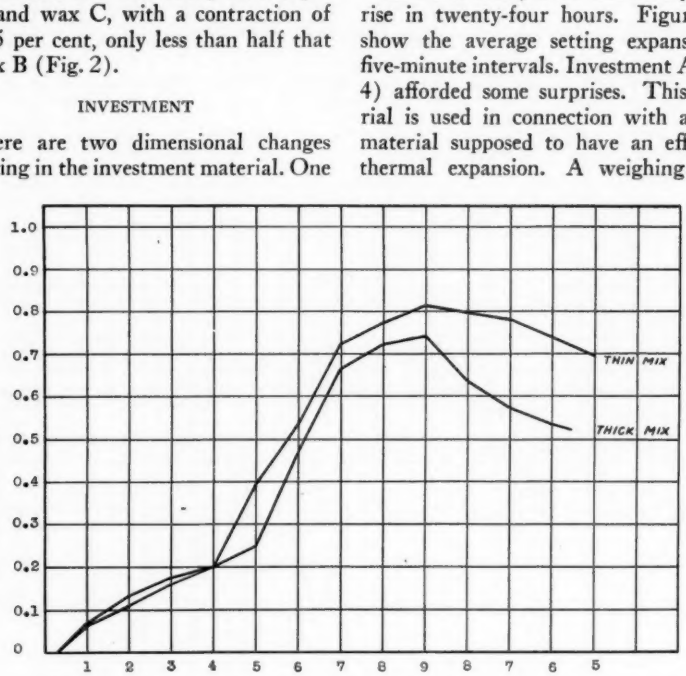

Fig. 15.—Average thermal expansion for each 100 degrees centigrade of D investment (water: powder, thick mix: 27 cc.: 100 gm.; thin mix: 31 cc.: 100 gm.). Left, percentages of expansion. Below, degrees centigrade times 100. (Sept. 18, 1936.)

of its effect on setting expansion. It was found that the greater the amount of the modifying powder used in the mix, the greater the setting expansion. This apparent fact was so surprising that the number of tests was increased to as many as ten on each mix. When this information was communicated to the manufacturer, he replied that the material does have "a slightly higher" setting expansion, owing to the powder present, but that there is a marked lowering in the thermal expansion.

The thermal expansion was determined by a method first described by Coleman.[1] A 200 mm. specimen (Fig. 8) was made in a mold (Figs. 9-10), the same proportions being employed as for the setting expansion tests. This was allowed to stand for twenty-four hours. It was then placed in a thermal expansion apparatus (Fig. 11), which is considerably improved over that used by Coleman, and heat applied. Thermocouple wires were connected to a potentiometer. The current was run into the furnace to heat the specimen to 700 C. (1293 F.) in ninety minutes, although the test was allowed to run to 900 C. Cooling curves were made in many cases, but only to a 200 or 300 degree drop, and not to room temperature (Figs. 12-15). The accompanying table shows the range of thermal expansion for the materials tested to be between 0.657 per cent for the thin mix of investment C (Fig. 14) and 1.225 per cent for investment A (Fig. 12), when mixed at 60 degrees, a mix in which there is none of the modifying powder. Just as it was surprising to find that the setting expansion of investment A, when mixed at the different room temperatures, does not run in a definite sequence as indicated by the manufacturer, so it was with the thermal expansion tests. It is obvious that the modifying powder does have a definite action in lowering the thermal expansion of the material, although not in order of temperature sequence. The setting expansion is so raised by the addition of this powder that the total of the setting and the thermal expansion is not much lowered in all of the mixes.

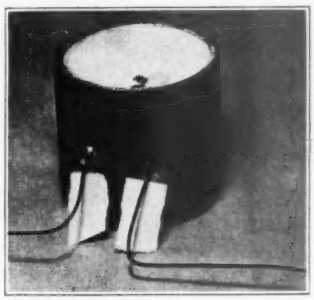

Fig. 16.—Thermocouple inserted in casting ring.

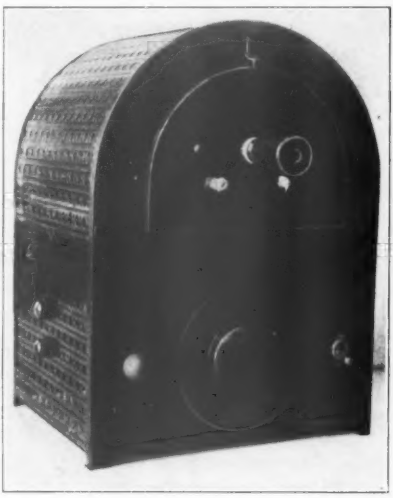

Fig. 17.—Electric furnace.

The loss of temperature between the removal of the crucible from the furnace and the moment of casting was determined by inserting a thermocouple in a

casting ring (Fig. 16) and connecting the ends to a potentiometer. The crucible was then filled with investments of the various mixes and allowed to set. These were then placed in an electric furnace (Fig. 17) for ninety minutes, when the maximum temperature was reached. The crucible was then removed from the furnace, placed on an air pressure casting machine and otherwise treated just as determined by the "practical technic." The ring was heated for a short time and the gold melted and cast, all within two minutes. The temperature was read every ten seconds. Twenty tests were made to determine an average result. It was found that an average of 65 degrees centigrade was lost over two minutes, provided the ring was heated with the torch prior to melting of the gold. This indicates an average loss of expansion of 0.034 per cent (Fig. 18). Several tests were made without heating the ring, with a simulation of the technic used with a casting machine of the centrifugal type. In these cases, there was a loss of 156 degrees (C.) in two minutes, indicating an average expansion loss of 0.077 per cent. In five minutes after the ring was removed from the furnace, the temperature of the investment inside the ring had cooled to 211 C.

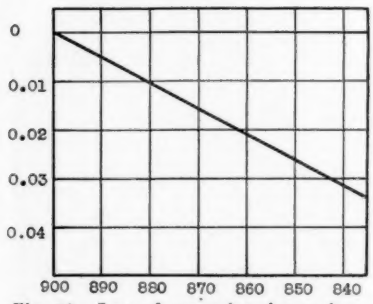

Fig. 18.—Loss of expansion due to loss of heat on removal from furnace. (Oct. 9, 1936.) Left, percentages. Below, degrees centigrade.

SUMMARY

1. Of the three most popular inlay casting waxes, used by twenty-one dentists in this community, wax C, a purple wax, has the smallest shrinkage from mouth to room temperature and is recommended when compensation is required. Wax A, a green wax, is recommended for use when compensation is not desired.

2. Investment A, of the four most commonly used in practice, is the only one having sufficient total expansion to compensate for total shrinkage.

3. The use of the modifying powder, although decreasing the total expansion, at the same time increases the setting expansion of the mix beyond reason.

4. The sequence of increase in the setting expansion, the thermal expansion and the total expansion of the mix does not follow the proper order as regards temperature. In other words, the quantity of modifying powder incorporated in the mix according to the temperature scale does not decrease the total expansion in proper order.

5. Investment B, advertised as a model investment, does not have sufficient expansion to compensate for the total shrinkages.

6. Investments C and D, both gray, advertised as investments for both inlay and models, do not have sufficient total expansion for compensation.

7. There is an average net shrinkage of 1.284 per cent, due to the shrinkage of the gold and the loss of expansion from temperature loss on removal from the heat, to which must be added the shrinkage of the wax in use.

8. It would seem helpful to use an electric furnace when the heat is known and can be controlled.

9. The ring should be well heated after it has been removed from the furnace and before casting.

PROSTHETIC OCCLUSION—A PROBLEM IN MECHANICS

By M. A. PLEASURE, D.D.S., Rego Park, L. I., N. Y.

THE object of this paper is threefold: (1) a consideration of the manner in which the form and arrangement of artificial molar and premolar teeth influence the stability and efficiency of full dentures, particularly the lower denture; (2) an attempt to draw up general specifications for an acceptable if not ideal form of posterior tooth pattern, and (3) an effort to give these specifications practical embodiment in a new tooth form.

The part which impression-taking plays in achieving stability through adhesion or suction is purposely omitted from consideration, since it is recognized that even dentures which fit the alveolar mucosa most precisely may traumatize underlying tissue when the bite or occlusion is incorrect. Such phrases as "lateral stresses," "tripping cusps" and "skidding of dentures" are regularly invoked to account for soreness under bases. Irritation of the mucoperiosteum implies inflammation and hyperemia, and these may initiate demineralization of underlying bone, with consequent resorption, closure of the bite and loss of fit of the denture bases—a vicious circle.

As a result, much emphasis has come to be placed on the importance of preventing occlusal traumatism by using adaptable articulators to aid in arranging the cusps so that they will accommodate themselves to the habitual chewing movements of the patient without clashing, and we have learned to spot-grind with stones and articulating paper in order to enlarge the scope of cusp movement. Those who have found these methods both laborious and inadequate have adopted with more or less enthusiasm the variety of non-anatomic teeth that have appeared in recent years. These seem to cut the Gordian knot of cusp interference by eliminating cusps altogether, but too often the anticipated advantages have not materialized.

If we regard critically the actual results attained by current technics of denture occlusion, we must admit that even the most conscientious and ingenious elimination of cusp interference cures skidding of the denture bases and tissue trauma only while the patient chews articulating paper. When a tough morsel of food is introduced, it is literally the monkey-wrench in the works which brings into direct opposition cusps which otherwise clear each other nicely. The dentures are comfortable most of the time, though not during meals—on the whole, an estimable achievement. The trouble has been, I maintain, that insufficient attention has been paid to the movements of the teeth in relation to the morsel of food which they are intended to cut. The resultant forces that chewing pressure generates on the occlusal planes of the teeth are the active cause of the lateral stresses which force the dentures to skid and to traumatize the alveolar mucosa. It is these resultants which have not been eliminated by adaptable articulators, spot-grinding or the use of non-anatomic tooth forms. The most significant phase of the chewing movement, from the standpoint of denture stability, occurs *before* the upper and lower teeth are in direct contact. Achievement of "balanced occlusion" through

multiplicity of contacts becomes an almost irrelevant *tour de force* when we acknowledge that the interposition of a bolus of food may upset such balanced dentures before stabilizing contacts can become effective. We propose to show that it is the morsel of food between the teeth which is the most important and most neglected factor in the stability of the lower denture. Analysis of the effects of the presence of a compressible morsel between the teeth will show why the concept of balanced occlusion, as ordinarily demonstrated, is inadequate to achieve effective stability.

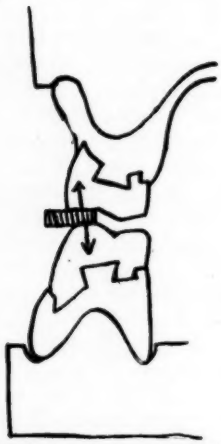

Fig. 1.—Relation of morsel of food to molars in working bite as sketched in literature of tooth manufacturer.

Figure 1 shows the relation of prosthetic teeth to the alveolar ridges (which act as fulcrums when dentures tilt) and to the substantially vertical line of biting force as it is figured in the literature of a prominent tooth manufacturer. It will be seen that only the primary force is indicated. No recognition is accorded the existence of a variety of resultant forces generated by the various inclined planes presented by the occlusal modeling of the teeth. It is an axiom of physics that a force acting upon an inclined plane generates a resultant at right angles to the plane. When a barrel is rolled up an inclined plank, it is this resultant which tends to bend or break the plank. If similar resultants are drawn into the diagrams in advertising literature, the effect of a bolus on the stability of a denture constructed with anatomic teeth becomes more clearly apparent. (Fig. 2.) Resultant R_3 is indicated with especial emphasis because it has been persistently ignored. F marks the direction of movement toward centric position and therefore the primary line of

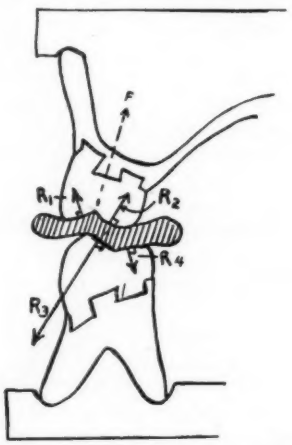

Fig. 2.—More realistic diagram of relation of morsel to molars. F, direction of biting pressure. Perpendiculars erected on the working faces of the cusps show the direction of the resultants. R_3 tends to tilt the lower denture buccally.

force. The cross-hatching in the bolus is parallel to this line. R_2 and R_3 are the most significant and most powerful of the resultants because the inclined planes on which they arise are so nearly at right angles to the primary force. R_2 is desirable, as it tends to seat the upper denture more firmly on its ridge and to stabilize it. R_3, which has not, to my knowledge,

previously been figured, shows the adverse effect of a high buccal cusp on the lower denture. It is to be noted that, at this stage of the chewing cycle, the tilting effect of this resultant is opposed only by the suction and adhesion, often conspicuously absent in lower dentures. Bilateral contacts, even when they are demonstrable during what we call the working-bite position, are rendered inoperative in the stage illustrated by the degree of opening induced by the bolus. Figure 3 shows that the greater the distance between the occlusal plane and the crest of the ridge, the more powerfully will this resultant tend to tilt the lower denture; *i.e.*, it is most

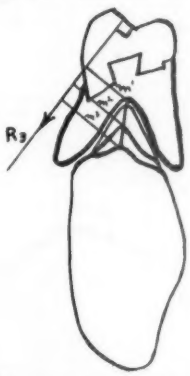

Fig. 3.—Diagram showing that the undesirable centrifugal resultant (R_3) grows progressively more active in proportion as the lower alveolar ridge is reduced by resorption.

active where resorption of the ridge has rendered the denture least stable. The torque, or "moment of rotation" or tilting force, is equal to the force multiplied by the perpendicular distance between the line of force and the axis of rotation. The tilting force generated by the buccal cusp becomes progressively greater as the ridge is resorbed.

When further closure has brought the teeth into so-called working bite, we see what has been referred to as the "rectangular space," which I prefer to call the "morsal space" to emphasize the fact that it is closely packed with semi-solid food, which resists further closure toward centric position. (Fig. 4.) The pressure generated by the resistance to this movement may be considered as equal in all directions per unit area (omitting consideration of escapements); but continued closure rapidly diminishes the occlusal area of the upper buccal and lower lingual boundaries of the morsal space, while the working area of the upper lingual and lower buccal boundaries remains constant. Increasing pressure thus tends to be concentrated

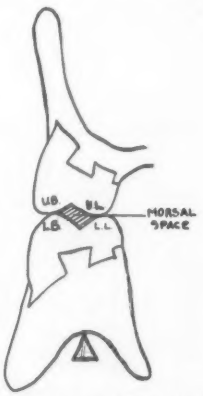

Fig. 4.—Morsal space formed by cusps in working bite. During chewing, it is filled with food which resists further closure toward centric relation. (The cross-hatching shows the direction of movement of the lower buccal cusp toward centric relation.)

more and more upon the lower buccal cusp and its antagonist, the upper lingual cusp. At this stage, if balancing contacts are available on the other side of the denture, they do help to prevent buccal tilting, but they cannot prevent a slight lateral shift of the entire lower denture, which may pinch and traumatize the lingual mucosa on the working side.

When natural teeth are set in their

alveoli, the upper transmit compressive stress chiefly to the palatal plate (from the interior of the socket), and the lower, as they close against a morsel, bear chiefly against the buccal plate, with tensile stress on the lingual plate and pericementum. When set on dentures, these same teeth produce a profoundly different effect on the supporting tissues. The compressive action is reversed, and stresses fall mainly on the upper buccal and lower lingual alveolar mucosa. If the lower denture is restrained by a tough morsel from following the mandible in its forceful movement toward centric position, a high pressure is built up between the lingual mucosa and the lingual flange in the lower denture and between the buccal mucosa and buccal flange in the upper—precisely the areas of most rapid resorption.

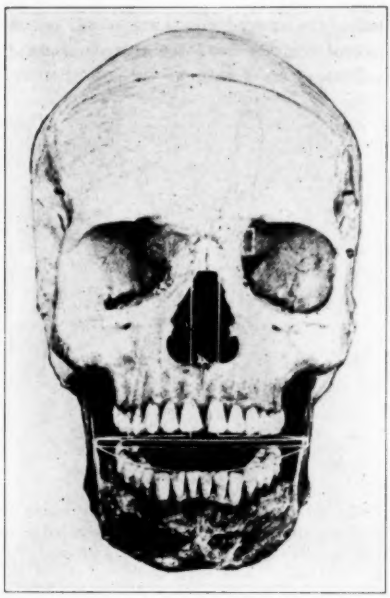

Fig. 5.—Application of spherical principle to natural dentition.

The frequently recommended procedure of setting the posterior teeth on a transverse curve of about a four-inch radius serves to bring the lower buccal cusp into greater prominence and aggravates the adverse effect described in the preceding paragraphs. (Fig. 5.) Such a transverse curvature gives rise to tilting forces due to the centrifugal resultants, even when cuspless teeth are used, such as Hall's. In the case of French's teeth, omission of one row of lower cusps diminishes, but does not eliminate, this effect. The lingual inclination of the occlusal facet of the remaining lower cusp, together with the definite buccal face of the upper lingual cusp, generates on the lower a resultant which falls outside the ridge

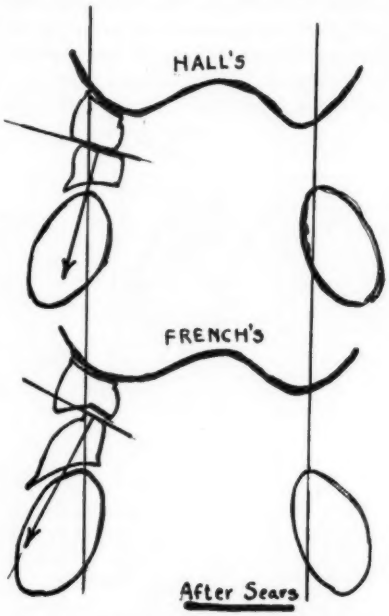

Fig. 6.—Diagram showing how cuspless, non-anatomic or mechanical teeth generate centrifugal tilting forces when arranged according to the so-called spherical principle.

fulcrum. (Fig. 6.) Even in Sears' channel teeth, wherein the lower teeth did not have a real occlusal surface, the upper lingual cusp against which the lower teeth were supposed to "mash" the morsel would generate the centrifugal resultant and the tilting effect on the lower, because action and reaction are equal and opposite.

The prosthetic significance with which Monson invested the so-called lateral or transverse curvature of the occlusal plane observed in many good natural dentitions is misleading. The cusps of the lower teeth do indeed often rest conveniently against the outside of a sphere of about a

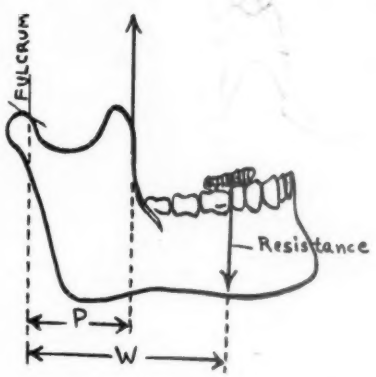

Fig. 7.—Mandible as Class III lever.

four-inch radius, but it does not follow that they move on such a sphere. Imitation of the Monson curvature in the arrangement of prosthetic teeth confers no visible advantage and increases the instability of the lower denture by bringing the lower buccal cusps into undue prominence. It betrays the lamentable tendency of prosthetic thought to pre-occupation with figures that are easily drawn and visualized, like perfect circles and equilateral triangles, but which are rarely or never encountered by the anatomist or physiologist.

THE CHEWING MOVEMENTS OF THE TEETH

Analysis of the movements of the teeth in relation to the morsel (in distinction to "mandibular movements") and determination of the direction of the resultants of chewing pressure are fundamental to the design of efficient dentures. The chewing movement differs essentially from that wherewith occlusal balance is demonstrated on the articulator. It is customary to display balance and freedom from interference by moving the lower teeth from centric position into working bite and by looking for the regularly interdigitating cusps on one side and for balancing contacts on the other. Cusp interference is conceived to be present when the lower

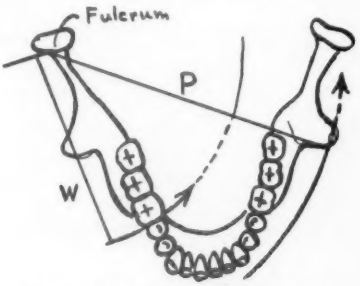

Fig. 8.—Mandible as Class II lever.

buccal cusps encounter obstruction in moving from centric into the lateral or working-bite position. My objection to this test of occlusion is that it involves a totally unrealistic movement of the lower jaw. That the movement from centric to working bite is not the essential masticatory effort may be recognized by consideration of the power of the muscles which effect the abduction as compared to the much greater power of the adductors, which include the temporal muscles, the masseters and the internal pterygoids. The really important obstacle encountered in chewing is the morsel itself, which opposes the patient's efforts to bring the

lower buccal and upper lingual cusps into that contact which is centric occlusion.

Centric occlusion may be defined as the normal termination of the essential masticatory movement, a definition which distinguishes it from the resting position, in which the teeth are normally slightly parted.

The chewing cycle may be divided into two phases:

1. Abduction: Depression of the mandible by gravity and the hyoid muscles,

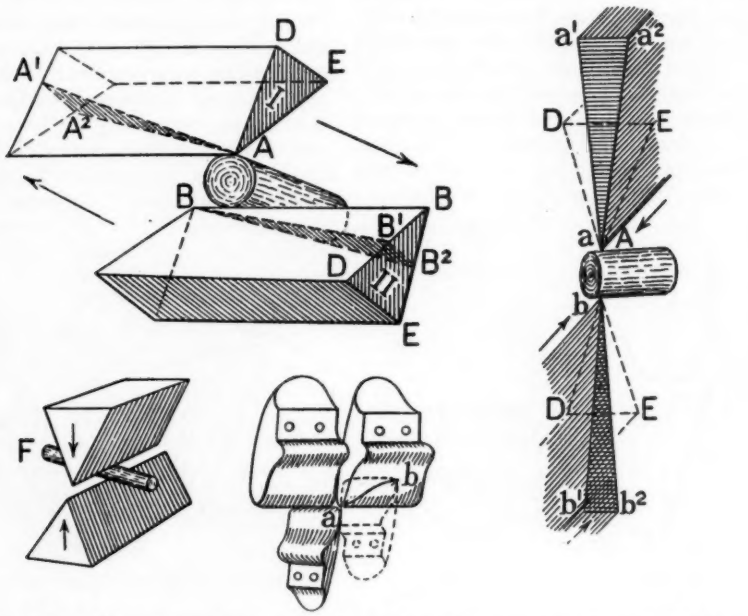

Fig. 9.—Effect of lateral movement in enhancing cutting efficiency of lower incisors. The four diagrams are from "Prosthetic Articulation," by George Wood Clapp. Below, left: "Fig. 110. Upper and lower teeth set to only straight up and down movement may be diagrammatically illustrated by the two wedges here shown. It requires much force to push them through the food, shown as F." Above: "Fig. 111. The sideways movement of the teeth may be here diagrammatically represented by two wedges and the food by the round body between them. If the wedges are forced vertically through, great pressure will be required. If the wedges be moved in the direction shown by the arrows, very much less force will be required. The reason is that the cutting form of the wedges is changed. With this motion the form of the wedge is not the triangle formed by the lines A D E, but the much sharper triangle which is drawn inside each triangle and lettered A—A^1—A^2 in the upper, and B—B^1—B^2 in the lower." Right: "Fig. 112. The dotted outlines reproduce the triangles A—D—E and B—D—E, while the solid outlines a—a^1—a^2 and b—b^1—b^2 reproduce the triangles A—A^1—A^2 and B—B^1—B^2, which were produced by the lateral movement of the triangles in Figure No. 111. The sharper triangles have about three times the cutting power of the triangles A—D—E and B—D—E." Below, center: "Fig. 113. The right lower incisor at 'a' is in the position of articulation with the upper right central. In cases with strong lateral inclination of the incisor path, it will return to occlusion, at 'b' by following the direction of the arrow. This path of return permits a relatively deep underbite and great cutting power."

etc., and a slight lateral shift toward the working side by contraction of the external pterygoid of the opposite side, which draws the condyle forward.

2. Adduction: Closure into the working bite, which incises a morsel from the bolus advanced by the cheek, and further closure toward centric position, effected by powerful contraction of the muscles of both sides against the resistance of the food packed into the morsal space.

Naturally these movements are highly coordinated and flow smoothly together.

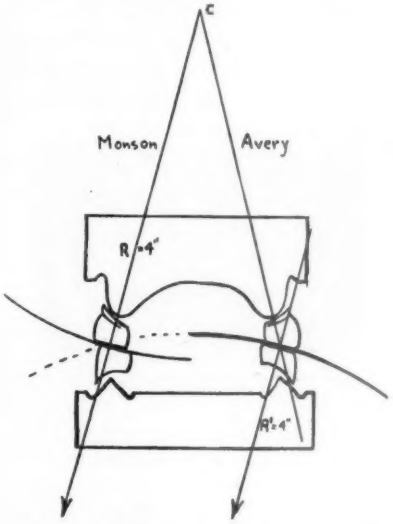

Fig. 10.—Diagram contrasting transverse curves.

The first phase, or abduction, is accomplished by slight effort, since there is little or no resistance to be overcome. The second phase is as forcible as the toughness of the morsel requires. With soft pulpy foods, the lateral shift of the mandible may be absent, and a simple vertical movement may suffice to crush and fenestrate the morsel and to mix it intimately with saliva. Tough fibrous morsels, such as raw fruit skins and fibrous vegetables, and especially cooked meats, require greater pressure and reflexly elicit the lateral shift, which bestows the mechanical advantages inherent in Class II leverage and in the sliding cut, which will be discussed later.

To reiterate: The essential chewing movement is adduction from working bite to centric position against the resistance of a morsel, a very different thing from the abduction from centric position to working bite, wherewith occlusal balance is demonstrated on the articulator.

THE MANDIBLE AS A LEVER

The muscles of mastication may operate the mandible as a lever of either the

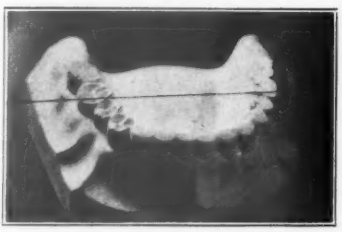

Fig. 11.—Plaster model carved to show anti-Monson transverse pitch of bicuspids and first molar to secure stabilizing resultants.

second or the third class, according to the nature of the morsel being chewed. With Class III leverage, the morsel is crushed mainly by the power of the muscles of the same side, which insert themselves between the fulcrum (condyle) and the work (morsel); an arrangement which allows relatively short muscles to effect movements of considerable amplitude at the expense of power. (Fig. 7.) As a lever of the second class (Fig. 8), the mandible is shifted slightly toward the working side in grasping the morsel, with concurrent advance sagittally of the condyle on the non-working side. Then the power of the muscles of the balancing, or

non-working, side retracts that condyle into the glenoid fossa, adding enormously to the crushing force. With the condyle of the working side acting as a moving pivot, the sagittal movement of the other condyle produces transverse or lateral movement of the teeth on the working side. (Fig. 8.) As a Class II lever, the mandible has a power arm (P) longer than the work arm (W), with a corresponding mechanical advantage and multiplication of force.

Although a transverse component in the closing movement reinforces the eccentric, or centrifugal or tilting, resultants generated by occlusal modeling of the anatomic pattern, these stresses are well tolerated by the natural denture because it is securely articulated to the jaws. Even so, periodontists advocate and practice the alteration of natural occlusal modeling in order to reduce transverse stresses on the tooth and periodontium. If available tooth forms are analyzed with reference to the requirements of a transverse element in closure against a morsel, it will be observed that all of them obstruct the essential masticatory movement to a great degree in that they possess surfaces which lie transversely to and thus block the usual path of return to centric position. For this reason, we ask our denture patients to learn to chew with a simple vertical motion and, if possible, on both sides simultaneously. But even if movement is confined to the vertical plane, the use of available tooth forms is often conducive to instability in that they present inclined planes which generate resultants directed away from the area of denture support, and these tilt the lower denture buccally. Because of the habitual and reflex nature of the transverse factor in the closing movement, it would be highly desirable to design teeth which permit and do not prohibit this motion by the penalty of tilting.

Fig. 12.—Dentures with posterior teeth disposed in anti-Monson fashion to secure maximum stability of lower denture. (There is reversal of pitch in the second molar.)

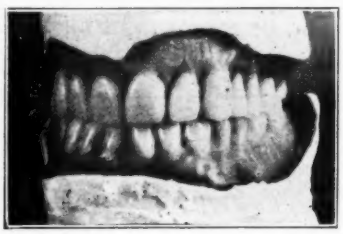

Fig. 13.—Dentures shown in Figure 12, in centric relation.

THE LOWER TEETH AS CUTTERS

If dentures could be made to tolerate this transverse movement, the effect would be more than an increase in the force of the bite as shown in the discussion of the mandible as a Class II lever. Obviously, the muscle power available to a denture wearer is far greater than can be comfortably supported by the alveolar mucosa. A measure which merely increased the force of the bite would also increase the pressure on the tissues, pressure which it is much more desirable to decrease. Therefore, it is important to observe that, besides the mechanical advantage previously discussed, the transverse element in the closing movement possesses the potentiality of increasing the efficiency of the posterior teeth as cutters and thus of diminishing the force required to close

through a given morsel, with concurrently reduced trauma to underlying tissues.

While endeavoring to become familiar with the principles which guide an engineer in the design of cutting tools, I came upon an editorial, "The Philosophy of Cutting," in a British journal, *The Engineer,* from which the following paragraph is quoted exactly:

We have all seen in operation the plain circular discs which are used for slicing our morning rashers. If the discs were at rest the pressure of the bacon against them would result in very indifferent cutting, and in none at all unless the pressure were great. But rotate the disc and the operation becomes one of ease and perfection. Consider, for example, the difference between the pressure cut and the slicing cut of a paring chisel, the latter leaving a glossy finish which the other cannot attain. Or, again, why will an inclined blade cut smoothly when one presented straight against the object will not cut at all? We shall no doubt be told that no edge is continuous, that every edge is more or less sawlike, and that the sliding cut owes its efficiency to these minute defects. Is that, we ask, true also of a fine drawn wire which makes a fairly efficient knife if pulled to and fro, but is valueless without longitudinal movement?

Fig. 14.—Upper denture (reversed); showing unobstructed path of lower teeth toward centric relation. (Posterior teeth of much more anatomic appearance have since been carved.)

The principle so clearly discussed in the quoted paragraph is really new neither to mechanics nor to surgery; it was employed by an eighteenth century French physician, whose instrument was designed with the edge at an angle to the vertical stroke of the blade. There can have been but few complaints regarding the efficiency of the machine named for Dr. Guillotin.

When the upper and lower teeth are enabled to approach each other through the morsel with a longitudinal sliding motion, the food is cut as well as crushed and much less pressure is necessary. It is required only that occlusal pattern and denture stability do not penalize such a natural chewing movement. In his book "Prosthetic Articulation," Dr. Clapp shows the utility of this movement in the case of the incisors by means of excellent diagrams. (Fig. 9.) The identical principle may be adapted to the posterior teeth; the lower molars and bicuspids should have buccolingual ridges or cutting edges running parallel to the path of closure.

The process of trituration as in a mortar and pestle (to which mastication is often compared) is appropriate to brittle or crystalline substances that readily undergo cleavage; it is unsuited to the reduction of gummy materials, as one will quickly discover if an attempt is made to triturate a rubber band or a bit of wax in the amalgam mortar. The effort to endow the posterior teeth with definite cutting edges as seen in several types of non-anatomic teeth is thus quite in line with the requirements of the cooked and gummy foods on which we chiefly subsist. For the modern diet, a sectorial type of tooth is more effective than a simple molar type. Recognition of this fact has led certain designers to offer posterior teeth much reduced in buccolingual diameter; but this is an undesirable solution of the problem. With each closure, such teeth divide the morsel into two portions, one passing lingually and one buccally. Because of the narrowness of the teeth, many such closures are required to com-

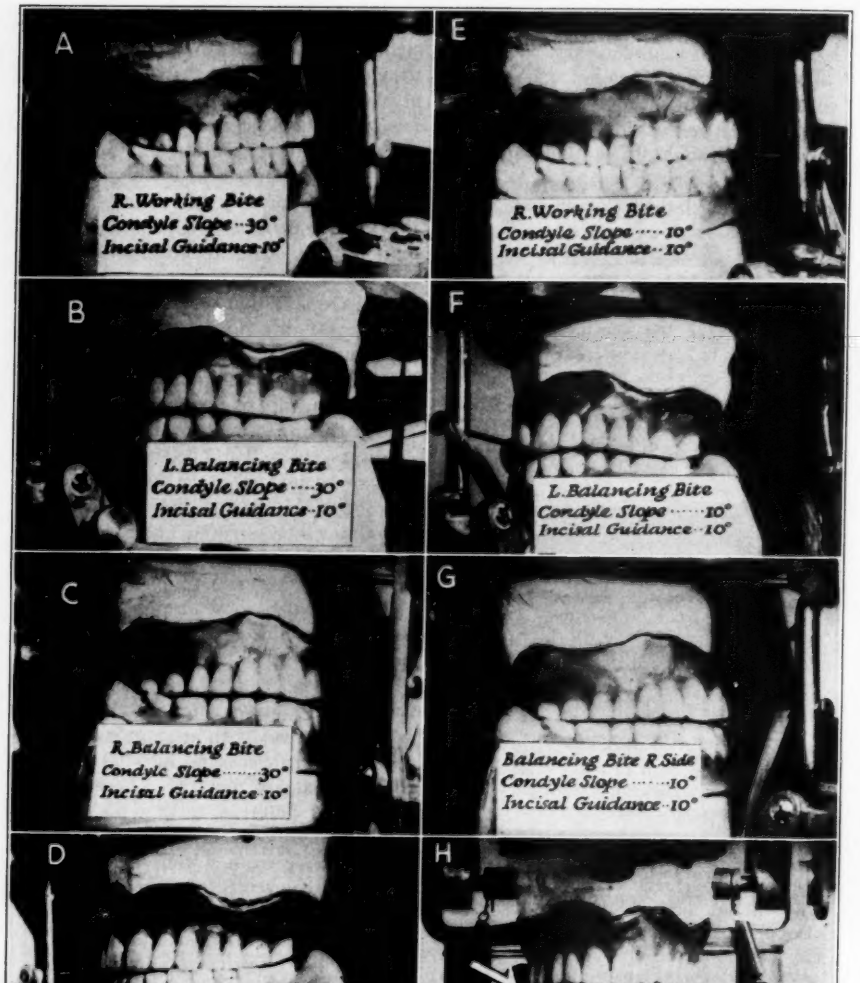

Fig. 15.—A to G, series of photographs showing same case throughout, but with the sagittal condylar slope set first at 30 and then at 10 degrees for comparison of balancing contacts. The articulator was set at 20 degrees while the teeth were waxed into place. H, same case in facial aspect. The partial cross-bite on the right side involves the first and second molars. Only three lower incisors were used.

minute the morsel and, after each one, the material must be reassembled on the occlusal surfaces by the action of the cheek and tongue. The notable increase in the activity of these muscles attending the use of narrow posterior teeth may serve to unseat the denture. It would appear to be more desirable to use lower teeth of normal buccolingual diameter and to reduce the width of the opposing upper teeth, as this would just as effectively reduce biting pressure between the upper and lower teeth, since action and reaction are equal.

It will be seen from the foregoing discussion that the evolution of mechanical tooth forms is a response to the functional deficiencies which critical operators have recognized, more or less clearly, in even their most carefully constructed dentures. It is evident that the evolutionary process must be carried further forward before we can hope for any notable improvement in the efficiency of full dentures. Although we cannot hope to foresee the exact forms of the prosthetic teeth of the future, we can presume that they will avoid the defects of current designs, and we can in general terms draw up tentative specifications for the teeth which will adorn the dentures of our declining years. Such an undertaking requires no clairvoyance and is not so rash and fruitless as might at first appear. It is common practice in other fields of technology. The aviation engineer expressed a need for a metal of unprecedented lightness and strength and the metallurgist proceeds by scientific methods to compound a series of such alloys. Partial dentures of modern design require casting alloys of both precious and non-precious constitution with exacting physical properties and high resistance to corrosion. And they have been produced. We know that we would like a denture-base material as plastic as rubber, as strong and conductive as metal, as beautiful as porcelain. Already, available synthetic materials give us practical intimations of ultimate success in this field as in others. What, then, do we demand of posterior teeth for full dentures? The manufacturers of teeth will surely strive to satisfy our requirements if only they can be reasonably certain that we are agreed as to what such teeth should accomplish.

TENTATIVE SPECIFICATIONS FOR PROSTHETIC POSTERIOR TEETH

1. Prosthetic posterior teeth should help to stabilize the dentures, particularly the lower, during that portion of the chewing cycle when the upper and lower teeth are in functional opposition through the intermediacy of the morsel of food and before they are in direct contact. While anatomic tooth forms tend to stabilize the upper denture, which is intrinsically the more stable, it is the lower denture which determines the efficiency and comfort of most sets.

2. They must provide for balancing between the upper and lower dentures on the non-working side during the last stage of adduction when intermaxillary pressures are highest.

3. They must not unduly restrict mandibular movements in any direction.

4. They should not diminish the opportunities for esthetic arrangement of the anterior teeth; *i.e.*, they should permit use of some vertical overbite.

5. They must readily accommodate a cross-bite arrangement of all or some of the posterior teeth without impairment of efficiency.

6. They must possess a degree of cutting efficiency or sharpness that will decrease the pressure required to cut fibrous morsels and diminish traumatism of denture-supporting tissues and thus prevent or measurably retard resorption of ridges.

7. They must provide for a definite centric relationship without such interlocking of upper and lower teeth as will impair freedom of movement.

8. They must not require extremely accurate registration of condyle pathways, etc. When set to a given registration, they should work efficiently in a broad range of cases on both sides of the articulator settings.

It is anticipated and indeed hoped that other desiderata will be suggested by thoughtful readers, but those mentioned probably cover the most desirable and important. They may serve as criteria whereby we can appraise current and proposed designs.

Thus far, the chief objects of discussion have been an appraisal of current practice and an effort to define the problem of denture occlusion in functional terms. It may be proper at this point tentatively to submit a possible solution.

It seems to us that a rather simple change in the character of the "plane" of occlusion will afford some interesting possibilities. Reference to Figure 2 shows how the primary biting force undergoes dispersion into several resultants the relative force and direction of which are determined by the area and angulation of the inclined planes on which they arise. Properly applied, the physical principle illustrated can help us to design posterior teeth that will increase rather than decrease stability of the lower denture.

During the process of seating a lower denture in a patient's mouth, it is usual to press the denture downward with the fingers of both hands simultaneously. If it were found necessary to use only one finger, stability would be secured by pressing downward and inward, just as, in testing a lower denture for adhesion to the mucosa, we pull downward and outward. By pressing inward, we direct the line of force medially to the crest of the ridge, which acts as a fulcrum, and tilting of the denture does not occur. To provide for pressure in such a direction during chewing, one can set the teeth to the lingual side of the crest of the ridge as advocated by MacMillan in an excellent study of denture occlusion; or one may provide for a resultant in the desired direction by using teeth with the occlusal surfaces at right angles to the desired force. This involves a transverse pitch exactly the reverse of that attendant on the Monson curvature. Reference to Figure 10 will show more specifically what this implies. The center of the lateral curvature will not be situated in the ethmoidal region, but somewhere below the mandible, in the region of the larynx. On recalling the manner in which a vertical force acts on an inclined plane, it will be apparent that such an arrangement will have the effect of pressing the lower posterior teeth on the working side downward and inward instead of outward as with the Monson curvature. Thus without any change in the spatial relation of the teeth to the tongue or other structures, the point on which the force of mastication is incident on the ridge may be moved several millimeters lingually. (Fig. 10.) In cases with poor lower ridges, the greater distance between the occlusal plane and the ridge crest increases the relative advantage accruing from this arrangement. It is conceded that this advantage is derived at the expense of the upper denture, but since the less stable denture determines the utility of the set, an increase in the stability of the lower denture will result in a net increase in the efficiency of the set, even though the advantage be gained at the expense of the upper.

If we could determine the tolerance of the alveolar processes to pressure, we would find that a patient could stand possibly twenty pounds of biting stress on

good dentures. If the lower alveolar mucosa were then anesthetized, the pressure tolerance would probably rise to almost thirty pounds. If similar numerical values could be assigned to the stability of dentures under biting stress on one side alone, a similar discrepancy would appear between the figures for the upper and lower. Suppose the upper will tolerate fifteen pounds of unilateral stress and the lower only nine pounds: Would it not be desirable and beneficial to add three pounds to the stability of the lower denture by subtracting from that of the upper? The net effect would be an increased tolerance of unilateral biting stress. The utility of a set of dentures is determined by the stability of the less stable, usually the lower, and not by the average stability.

The anti-Monson lateral pitch of the posterior teeth herein advocated was first proposed by the Avery brothers in 1929 and 1930, but it was coupled with a technic employing an elaborate system of interdigitation between upper and lower occlusal elements of very original pattern. In the extended discussion that follows the second paper by the Averys, Dr. Paterson objects to this device because his experience with the technic of grinding in bite-rims in the denture patient's mouth has never resulted in such a curvature. My own experience with ground-in bite-rims confirms that of Dr. Paterson, but further study has led me to discard the grinding-in process as deceptive and unscientific. With the bite-rims in the mouth, the patient does not execute masticatory movements, the mandibular excursions being aimless and without functional significance. To argue that they are subject to the guidance of the temporomandibular joint is fallacious, as that joint is distinguished by the great variety and freedom of movement that it permits rather than by its capacity to restrict movement to given limits. MacMillan acknowledges such an opinion in a paper previously cited (J.A. D.A., July 1930, p. 1219) and my own work has convinced me that the rôle of the condyle in its loosely fitting socket has been much overemphasized in prosthetic doctrine. It should be our object to supply dentures which permit just as much freedom of movement in the dental region as does the articular mechanism in the glenoid fossae, which is practically a universal joint.

But to return to the anti-Monson transverse curve as advocated by the Avery brothers: It is apparent that such an arrangement does indeed deprive the upper denture of a stabilizing factor, but in the interest of increased total efficiency. The stability of the upper denture during speech, laughter, coughing, sneezing, etc., is in nowise affected by this arrangement. While ground-in bite-rims never show such an apparently atypical occlusal pitch, it is frequently seen in human dentitions showing mature use and belonging to persons who enjoy an abrasive diet. Our own food is so free of dirt, soil and resistant particles of every type that it is more of a lubricant than a source of wear. Well-worn human teeth are an unequivocal record of the chewing movements of the jaws to which they belong. Although the greater incidence of wear on the lower buccal and upper lingual cusps is commonly attributed entirely to the greater width of the upper arch, that is, the buccal overjet, I am preparing to submit, in another paper, the evidence of measurements on scores of human skulls that the buccal overjet is not directly related to the incidence of cusp wear. Carnivorous and herbivorous animals have distinctive chewing movements appropriate to the requirements of their dietary; and is it too unlikely that the human jaws acquire a type of movement mechanically suited to the prevailing consistency of the diet, and that the resulting wear of the teeth

truly represents the prevailing line of movement?

The anti-Monson transverse pitch as originally advocated by the Averys possessed the serious defect of completely forfeiting the advantage of bilateral or balancing contacts during the last stage of the masticatory cycle, when occlusal pressures are near a maximum. Probably this, together with their insistence on precisely interdigitating cutting edges, is the reason that their design has not achieved wider application and recognition. Fortunately, it is possible to retain both stabilizing principles. Study of the incidence and distribution of occlusal wear has convinced us that most chewing is performed by the first molar and the two bicuspids, and far less by the second and third molars. Despite their considerably later eruption, the bicuspids are often as badly worn as the first molars, and usually far more worn than their almost contemporary second molars. Thus, it becomes apparent that the last molar of a denture may be set on an orthodox transverse curve so as to provide for the desired balancing contacts at small risk of serious centrifugal resultants because the second molars are but little used in chewing and rarely come under the influence of the morsel. The proposed reverse or anti-Monson curvature may thus be confined to the bicuspids and first molar to provide centripetal resultants of chewing pressure on the morsel, the while the second molars are pitched in the opposite fashion in order to provide balancing contacts during the last stage of the chewing cycle.

Figure 11 shows a plaster model with the lower teeth carved to conformity with the double set of transverse curves advocated, and with the occlusal surfaces on the right side recarved into substantially transverse or buccolingual cutting ridges. Figure 12 shows a set of dentures with teeth arranged as is proposed. Figure 13 shows the dentures with the teeth in occlusion, and Figure 14 the upper denture in perspective and upside down to display the anteroposterior disposition of grooves and ridges, which keep the morsel from slipping away from the advancing lower teeth. (Upper teeth have since been carved which are much more anatomic in occlusal modeling and still effective in holding the morsel.) Figure 13 shows also how the proposed arrangement facilitates the adduction of the mandible from working bite to centric position, because the lower teeth are, in effect, sliding downhill on an incline presented by the upper teeth. The transverse cutting ridges of the lower teeth thus acquire a linear sliding mode of advance against the morsel which is equivalent to the rotation of the disk cutter previously mentioned, and in effect to the lateral excursion of the incisors as described by Dr. Clapp. The linear translation of the cutting edges as they advance through the morsel enables them to cut with increased sharpness or with reduced pressure upon the supporting tissues. No change is contemplated in the anteroposterior curve of Spee, which helps to maintain molar contacts during protrusive movements.

When available types of cuspless teeth are set in the fashion advocated by adherents of the Monson spherical theory, a vertical overbite in the incisor region is not tolerated, because of the absence of such a relationship in the posterior teeth. This situation does not apply to my arrangement. The downward pitch of the occlusal plane from a high lingual to a relatively lower buccal border, together with the divergence of the left and right rows of teeth as we look posteriorly, brings an increasing diameter of the lower denture under a given diameter of the upper denture during mandibular protrusion. This, with the curve of Spee, lifts the dentures apart exactly as an antero-

posterior cusp angle would do, and permits use of a slight vertical overbite in the incisors.

Lacking teeth carved in accordance with the several stabilizing and cutting principles herein described, I have regularly employed Hall's teeth, after appropriate alteration, as the nearest available approximation. The bicuspids and first molars are set with the lingual borders higher than the buccal to provide some of the required downward pitch. This is not carried to the point where the necks of the upper bicuspids become prominent to an unsightly extent. The downward lateral pitch is then further increased by judicious grinding of the buccal half of the lower occlusal surfaces and the lingual half of the upper occlusal surfaces. This principle is rigidly adhered to whenever the occlusal surfaces require any adjustment after completion of the dentures, *except in the second molars.* The second molars are set with the buccal borders higher than the lingual so that the occlusal pitch is downward toward the lingual surface. Adjacent portions of the occlusal surfaces of the first and second molars are then ground to achieve a gradual transition between the oppositely pitched occlusal segments. The distal border of the second molar is elevated to create a curve of Spee that maintains contact as the condyle descends the slope of the articular tubercle during mandibular protrusion. A generous buccal overjet, one-fourth to one-third the buccolingual width of the first molar, is always employed to avoid cheek biting. Variations such as complete or partial cross-bite, or omission of one or more bicuspids or of a lower incisor are often resorted to, and cause no complications whatever. Figure 15, H shows a set-up with only three lower incisors and a partial cross-bite on the right side.

The occlusal scheme I present is adaptable to a wide range of individual technics. Using an adaptable articulator, I have found that considerable change in the condylar readings has astonishingly little effect on the proper mutual support (balancing contacts) on the non-working side. The series of photographs, Figure 15, A to G, shows a set-up articulated with the condylar guidance adjusted at twenty degrees sagittal inclination, and then tested for balancing contact with the inclination altered to both thirty and ten degrees. As will be readily seen, satisfactory balance exists in the lateral positions at both these condylar guidances. This tolerance of a wide range of condylar pathways is a distinct advantage to an operator who does not take tracings or other registrations of the condyle paths or who uses an articulator set for average conditions. When a simple hinge instrument is used, the waxing up of the second molars should be done in the mouth of the patient and adjusted until balancing contacts are observed in both lateral and protrusive movements.

It will be seen that while the occlusal scheme described and advocated is a striking departure from the familiar Monson curvature, it is similarly based on observation of human occlusal phenomena. But whereas the Monson theory is supported by the anatomic characteristics of unworn dentitions of exceptional excellence, my own conclusions are based on dentitions showing the effects of prolonged physiologic use, with the teeth ground in to a high degree of integration with prevailing paths of functional movement. My arrangement has more in common with the Avery procedure, which has been shorn of excrescences that restrict movement, and further modified to secure the additional advantage of bilateral balancing contacts in the second molar region. The advantages may be summarized as follows:

1. Enhanced stability of the lower denture during closure against a morsel of food.
2. Unimpaired balancing contacts.
3. Increased cutting efficiency because of the longitudinal sliding movement of the lower cutting ridges (not available when Hall's teeth are used as at present).
4. Reduced occlusal pressure and tissue trauma.

While the proposed occlusal scheme is claimed to be tolerant of many and great variations in technic and application, it is not tolerant of careless workmanship, nor is it advocated as a panacea for all the manifold deficiencies of full dentures as compared to natural teeth. While little has been said of esthetics and nothing at all of impression-taking, it is not implied that these factors are not of profound importance in building satisfactory dentures. My purpose has been to describe an occlusal scheme which I have found to be more efficient in that it permits my patients to chew their accustomed food in their habitual manner and in comfort. Comment and criticism from readers who may try this scheme are invited.

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THE ECONOMIC VALUE OF AMALGAM IN OPERATIVE DENTISTRY AND THE TECHNIC OF ITS USE

By GEORGE M. HOLLENBACK, D.D.S., Los Angeles, Calif.

FOR some time, there has been a tendency on the part of the members of the dental profession to relegate operative dentistry to the background. Prosthodontia, exodontia, periodontia and, to some extent, orthodontia have apparently occupied a more important position.

This is well borne out by the contents of most of the popular dental journals and the programs furnished by most dental societies. In both instances, much more attention is paid to the removal and replacement of the natural teeth than to preventive measures, which would go a long way toward rendering the removal and replacement of teeth unnecessary.

Through the knowledge which we possess, and when this knowledge is correctly utilized, the ravages of dental disease can, in most instances, be quite well controlled. I do not think it would be an overstatement to say that, if the majority of persons could receive the benefits of present-day knowledge of operative and preventive procedure, most of them

(Read before the Section on Operative and Preventive Dentistry at the Seventy-Third Annual Midwinter Clinic of the Chicago Dental Society, February 16, 1937.)

could retain their natural teeth in a serviceable condition throughout the entire span of life. This is a sad commentary on the present state of dental practice, when we consider the large number of people who are forced to accept artificial substitutes during middle life, many years before such a calamity should overtake them.

Of course, in fairness we must admit that there are many people to whom good operative dentistry is denied for purely economic reasons. Also in fairness, we must admit that the majority of those to whom good operative dentistry is economically available are not receiving the type of service that they should. This

Fig. 1.—Occlusal view of Class 2 amalgam filling in lower molar. If this cavity were prepared for gold-foil or an inlay, the occlusal outline form would be as indicated by the dotted line, an acute angle resulting in the filling at B, which, while entirely permissible for gold, would be highly undesirable for amalgam, owing to its brittleness. The cavity as prepared for amalgam permits the amalgam to form nearly a right angle at B, strength to withstand occlusal stress resulting.

must be due either to the inability of the members of the profession to render such service or to carelessness or indifference on the part of many of them. This condition can and must be remedied.

It behooves us, as a profession, to render it possible for many of these people to receive adequate attention. This can be done: 1. By careful periodic dental examination so that incipient dental disease may be discovered and treatment instituted with the minimum consumption of time and expense. 2. By conducting dental practice in as efficient a manner as possible. 3. By so systematizing and standardizing operative procedures that the individual operator will be enabled to do more work and work of a higher quality in a given length of time. 4. By using materials of such nature that not only the cost of the materials themselves, but also the necessary expense pertaining to their use, will be much less.

It is unfortunately true that most of

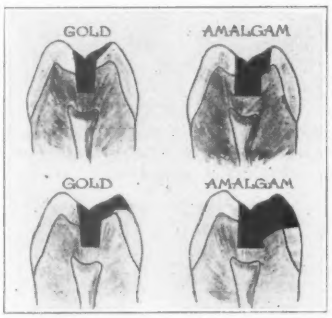

Fig. 2.—Buccolingual cross-section of upper bicuspid with gold and amalgam restorations, illustrating the necessity of so preparing cavities for amalgam that a sufficient bulk of material can be used to withstand occlusal stress. It should be noted that no cavosurface bevel is used for amalgam.

the materials which are needed for good restorations are of such nature that the expense attending their use is comparatively high and, in some instances, the materials themselves are very expensive. This almost entirely prevents their use for patients in the lower income levels.

There are a number of filling materials available which are low in cost. Three of these are in quite general use: zinc

cements, silicious cements, popularly called synthetic porcelain, though they are not porcelain, and amalgam. Amalgam, when correctly used, will permit restorations of a really fine and enduring character. The two others must be regarded as purely temporary and quite generally unsatisfactory, for many reasons.

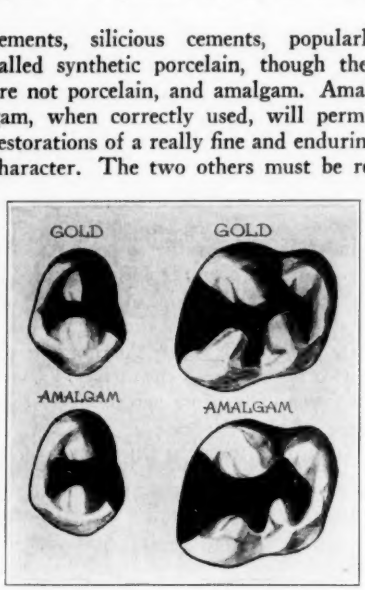

Fig. 3.—Occlusal view of gold and amalgam restorations, showing comparison of outline form and width of occlusal step.

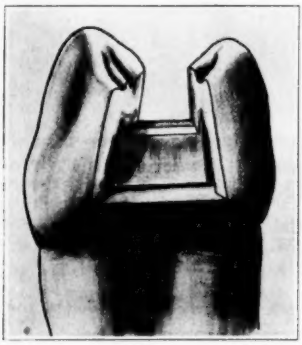

Fig. 4.—Proximal view of mesioclusodistal cavity prepared in upper bicuspid. The very definite outline and resistance forms are designed to give not only proper extension, but also the maximum of resistance to stress.

Amalgam itself is not only inexpensive, but also its use, when thoroughly mastered, is much less time consuming than the use of any of the other good materials. For this reason, it can be made available to a greater number of patients than any of the others. Amalgam is popularly regarded as a cheap material in every sense of the word, by both the laity and the

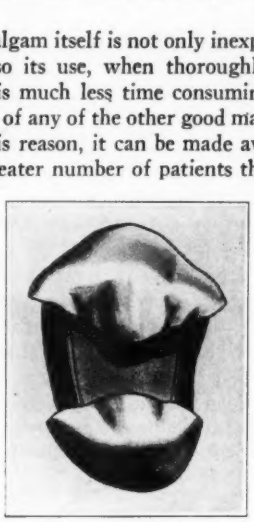

Fig. 5.—Occlusal view of mesioclusodistal cavity prepared in upper bicuspid. The very definite outline and resistance forms are designed to give not only proper extension, but also the maximum of resistance to stress.

Fig. 6.—Class 5 cavity as prepared in a bicuspid. It is recommended that these cavities be extended rather widely so that all margins are, as far as possible, placed in immune areas. For patients who have a high resistance to caries, these cavities may be less widely cut.

members of the profession. It amply deserves this bad reputation, but it is not the material itself, but the manner in which it has been abused, that should receive the blame. While it is true that amalgam restorations can be more economically produced than any other type, there is no reason that the dentist should not be well remunerated for this service by those who have the ability to pay. In serving patients of this class, the fee should be computed, not on the cost of the material nor on the time consumed in making the restoration, but on the value of the service to the patient. Therefore, the use of amalgam under such conditions is worth and should command a good fee.

Fig. 7.—A disto-lingual view of extensive cavity preparation in upper molar, the disto-lingual cusp being entirely destroyed. The cavity preparation embodies a very high resistance form and permits of sufficient bulk of material to withstand the heavy stress to which such large restorations are subjected.

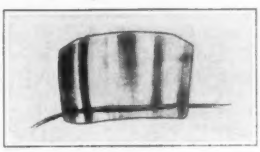

Fig. 8.—Modified Black matrix of stainless steel 0.002 inch thick. Small holes are punched adjacent to the lower corners to receive the waxed floss with which it is held to the tooth.

VARIATION IN CAVITY PREPARATION

The underlying principles of cavity preparation for the different kinds of filling materials are the same, but for each material some slight changes are necessary in cavity preparation to conform to the physical properties or methods of manipulation peculiar to each individual material. For convenience, I shall consider as standard the cavities prepared for the reception of gold-foil. Amalgam differs from gold-foil in many respects. First, its crushing strength is much lower. Second, its tensile strength is by comparison still lower. Third, it is not so good a thermal conductor as gold-foil. Fourth, in appearance it is even more displeasing than gold-foil. Fifth, it is a plastic and is more easily manipulated than gold-foil.

Fig. 9.—Matrix ligated to prepared tooth. The ligature should be passed around the tooth two or three times. The matrix extends 1.5 to 2 mm. beyond the buccal and lingual axial margins.

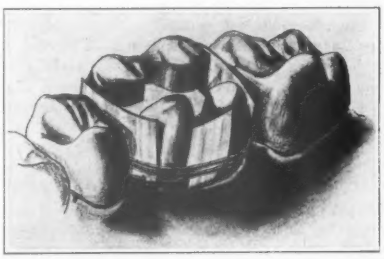

Fig. 10.—Matrices adjusted to mesial, distal and lingual aspects of tooth with a complicated cavity.

These differences under certain conditions necessitate modifications of the standard types of cavity preparation. I shall consider these differences in the same order that they have been enumerated. Less crushing strength renders it necessary that all cavities, except those that are surrounded by four strong walls, be cut deep enough that a sufficient bulk of material can be used, and thus the restoration be enabled to withstand the stress of mastication. So-called edge strength being practically analogous to crushing strength, it is evident that amalgam will not long endure when carried out to a thin edge, or over an obtuse or shallow bevel.

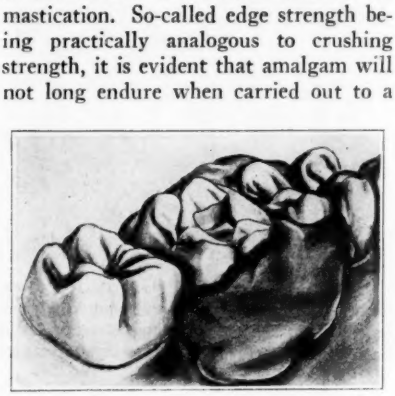

Fig. 11.—Matrix securely reenforced with low-fusing modeling compound. The matrix is so securely held that it will not yield even when heavy condensing force is used. Any type of matrix which will yield is unfit for use.

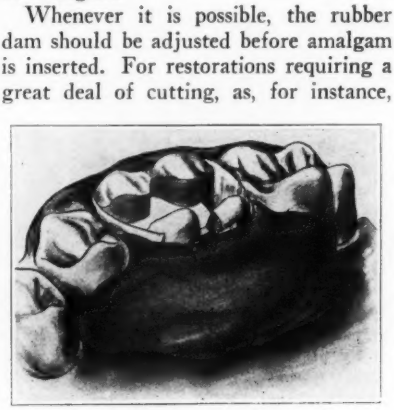

Fig. 12.—Matrix securely reenforced with low-fusing modeling compound. The matrix is so securely held that it will not yield even when heavy condensing force is used. Any type of matrix which will yield is unfit for use.

As for tensile strength, the lack of it in amalgam renders it imperative that all occlusal steps which are in any way utilized in the retention of the filling be cut proportionately wider and deeper than when gold-foil is used. Its thermal conduction being less than that of gold-foil, amalgam may be used safely in more deeply seated cavities. Proper discretion should always be displayed in taking advantage of this. The appearance being even more displeasing than that of gold-foil, the buccal extension of proximal cavities in the upper molars and bicuspids should be kept to the minimum. Amalgam being a plastic material which may be condensed and adapted by hand pressure, it is not necessary to secure the same convenience form as when gold-foil is used.

Figures 4 to 7 show a number of typical cavity preparations for the reception of amalgam.

Whenever it is possible, the rubber dam should be adjusted before amalgam is inserted. For restorations requiring a great deal of cutting, as, for instance, where a large portion or all of the occlusal surface of a posterior tooth is to be restored, it is sometimes best to roughly prepare and block out the cavity before the dam is adjusted. This will save considerable time. All of the fine details of the cavity are developed after the dam is adjusted and the field is rendered dry and visibility obtained.

As regards instrumentarium, nothing is required further than that possessed by any well equipped operator. In deep-seated cavities, it is best that sterilization be produced by precipitating ammoniacal

silver nitrate on the cavosurface, which has been previously dried by blasts of warm air. Caution should be used to protect frail or unsupported enamel walls, as they will be permanently discolored if silver nitrate is precipitated on them. They may be protected by a thin covering of varnish. After precipitation, all the silver is removed from the margins. If the pulp is closely encroached on, a cement base should be placed, a sufficient space, to be occupied by amalgam, being left in all cases to give ample strength.

It is suggested that in making a cement base, the cement be mixed to a thick creamy consistency and the mixture completed with alloy filings. This is thoroughly packed into the cavity and, when set, may be cut away with chisels and excavating burs to give the desired cavity form. This alloy-impregnated cement is very strong and will not tend to crack and chip away when cut. In fact, it can be cut almost exactly the same as dentin. The toilet of the cavity is now made by washing thoroughly with hydrogen peroxide, drying and wiping out with a pledget of cotton saturated with chloroform. This will remove all débris and render the cavity clean. Under no condition should alcohol be used for this purpose; not only does it produce painful dehydration, but also albuminous material that might be present is coagulated and fixed on the cavity walls. All cavities involving two or more surfaces of the tooth require a matrix before the filling is inserted, as no plastic, and least of all amalgam, can be adapted to cavity walls unless closely confined, so that heavy pressure may be used in its condensation. It is also desirable to use a matrix on all large Class 5 cavities involving the buccal surface of molars and bicuspids. Figures

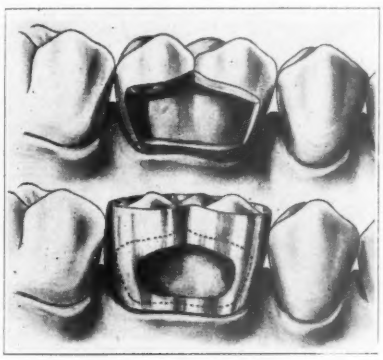

Fig. 13.—Type of matrix for large Class 5 cavities in molars and bicuspids. It is made of a thin copper band with an opening somewhat smaller than the cavity. The opening must be large enough to permit ready access to all portions of the cavity. (Suggested by J. M. Prime.)

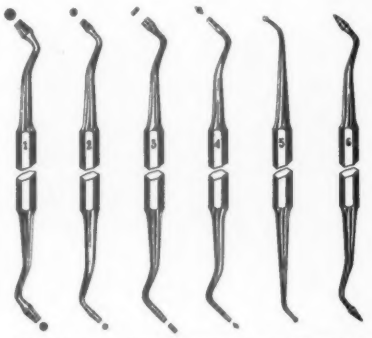

Fig. 14.—Author's selection of amalgam condensers. Instruments 1 and 2 are double-end round flat-faced condensers from 1 to 2.5 mm. in size. No. 3 is a double parallelogram 0.75 by 2 mm. One parallelogram is parallel to the long axis and the other at right angles to it. No. 4 is a double-end diamond-shaped condenser for use in sharp angles. (Compare Fig. 17.) No. 5 is a very small double-end burnisher. One end is 0.5 mm. in diameter and the other 1 mm. No. 6 is a double-end cone burnisher, one end of which is quite sharp and the other less so. This instrument is used for smoothing out sulci and fissures immediately after carving.

8 to 13 show how matrices are adjusted for these various types of cavities.

SELECTION AND PREPARATION OF THE AMALGAM

There are a number of alloys on the market which, when correctly manipulated, will give satisfactory results. Any alloy possessing the following qualifications is suitable for use: 1. It must be clean and free from foreign matter and oxides. 2. It should be finely cut, although an alloy containing graded sizes of particles may be satisfactory. 3. It should readily combine with mercury. 4. It should have a fairly wide mixing range. 5. When mixed, it should form a clean smooth plastic mass, which can be readily adapted to cavity walls. 6. Its initial contraction should be small and be followed by quick recovery, and the ultimate expansion should not be excessive. 7. The setting time should be so adjusted that ample time will be allowed for correct insertion of the filling. 8. It should possess ample strength to withstand the stresses to which it will be subjected. 9. It should be capable of taking and maintaining a high degree of polish.

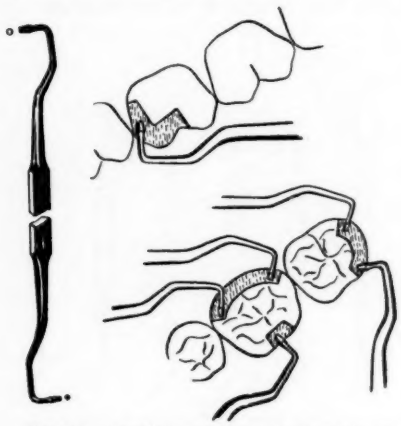

Fig. 15.—Special condenser for cavities of difficult access. One face is 1.5 mm.; the other, 2 mm.

For amalgamation, a No. 8 mortar and pestle is recommended. Proportions of alloy and mercury should be those recommended by the manufacturer, five parts of alloy to eight parts of mercury usually being recommended. In trituration, the pestle should be held with a pen grip, using a pressure from 2 to 3 pounds. Approximately 150 revolutions per minute of the pestle should be used. Trituration should be maintained until the mass becomes smooth and plastic, presenting a bright surface. This is a safe procedure with most alloys, but there is at least one on the market that requires a great deal more trituration to prevent excessive expansion. The time required will be from thirty seconds to nearly two minutes, depending on the alloy used. When trituration has been completed, the amalgam is removed from the mortar and placed in a small piece of rubber dam, which is folded and twisted over it, and the mixing finally completed by rolling the amalgam vigorously between the thumb and finger

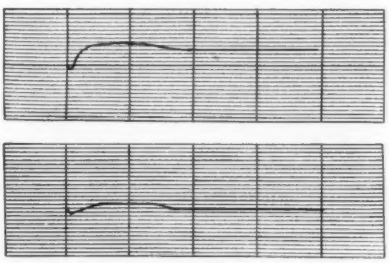

Fig. 16.—Bad results of burnishing amalgam during condensation. Above: Test specimen No. 1, mixed forty-five seconds in No. 8 mortar and pestle; packed with flat-faced condensers without burnishing. (Test begun seven minutes after starting of mix.) Below: Test specimen No. 2, mixed as that above. Packing was done with round-faced condensers by burnishing. (Test begun seven minutes after starting of mix.)

five or six times. This will evenly amalgamate the entire mass, and any particles that have not been well coated with mercury will be taken care of.

It should always be borne in mind that less trituration tends to increase expansion. With greater trituration, the expansion grows less. Finally, a point is reached where the mass will be neutral. With still greater trituration, contraction results, being in proportion to the time the mass is overtriturated.

INSERTION OF AMALGAM AND CONDENSATION

To make an amalgam filling correctly, it is necessary that a suitable set of condensing instruments be used. The number of instruments required is not great, but they must be of suitable form and size, so that all portions of every cavity can be readily reached. Figures 14-16 show my own selection of instruments, which have proved quite satisfactory for the purpose. It will be noted that one of these instruments is diamond-shaped to permit ready access to the acute angles presented by matriced cavities. The working surface of the instruments are not serrated, as I believe serrations are neither desirable nor necessary. Amalgam condensers should have fairly large handles, as a secure grip is necessary for the heavy pressure used in condensing. The pressure required for condensing amalgam is dependent on the size of the face of the condenser used. For a 2.5 mm. face condenser, from 10 to 12 pounds will be required. For smaller condensers, the pressure may be proportionately reduced. Amalgam should always be condensed by a series of direct thrusts, and burnishing should not be resorted to, as it tends to produce overamalgamation and shrinkage of the filling.

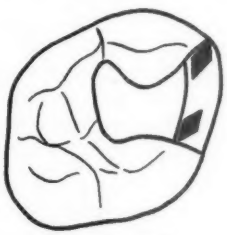

Fig. 17.—Ready accessibility of angles to diamond-shaped condenser.

The filling is started by placing a small quantity of amalgam in the cavity, from which none of the free mercury has been removed, and forcing it to place, as large a condenser as the cavity will accommodate being used. The resulting free mercury is removed from the cavity and condensation completed by using a small-face condenser, stepping very carefully to secure perfect condensation of every particle of the mass. The diamond-shaped condenser is now used to adapt the amalgam thoroughly to the buccal and lingual axial margins in all compound cavities.

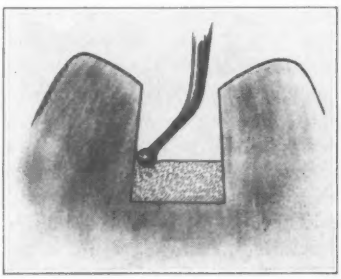

Fig. 18.—Final adaptation of amalgam by small ball burnisher.

To assure its perfect adaptation to the walls of the cavity, the amalgam should now be lightly burnished along the cavity walls, a very small ball burnisher being used, with very light pressure. This will perfectly adapt the material to the cavity walls. Each portion added to the filling

is treated in exactly the same manner, except that a portion of the free mercury is removed by pressing the amalgam between the folds of a napkin. When the cavity has been approximately seven-eighths filled, the free mercury is removed from the remaining portion of the mass and the latter is added to the filling a little at a time, all free mercury being removed as it comes to the surface. The margins are completely covered and the filling is built to considerable excess. This will tend to absorb most of the remaining free mercury. If condensation has been well carried out, so much of the mercury will have been removed from the filling that setting will be quite rapid, and it will be necessary to wait only three or four minutes before carving can be started. The excess is first removed from the occlusal surface and that adjoining the matrix. The retaining modeling compound is now broken away, the ligature cut and the matrix removed by careful displacement, either buccally or lingually. As the matrix material is only two-thousandths inch thick, enough separation is easily secured to compensate for its thickness.

The proximal portion of the filling is now carved accurately to shape, with gold knives and suitable carving instruments. Care must be taken to prevent overcarving and the exposing of margins. The occlusal surface is carved approximately to form. By this time, the amalgam will be quite well set. The rubber-dam is now removed and the occlusal surface spotted with carbon paper and carefully carved to exact occlusion. It is probably true that most amalgam fillings are carved short of occlusion, which is most undesirable. All grooves and all sulci are now burnished smooth with small sharp cone-shaped burnishers. This will render the final polishing much easier.

The patient is dismissed with instructions to return in twenty-four hours for final finishing and polishing of the filling. In finishing, the gingival margin is polished with fine cuttlefish strips. The buccal and lingual axial margins are polished with fine cuttlefish and crocus disks. The occlusal margins are finished exactly flush, with small knife-edged carborundum wheels, and the entire occlusal surface is polished with bristle brushes and fine pumice stone. Considerable care must be exercised or some of the occlusal form will be obliterated. Final polishing is done with a soft bristle brush and dry chalk. With this technic, it is not necessary to polish the contact point, as the amalgam has been condensed against the perfectly smooth surface of the stainless steel matrix.

CONCLUSION

I wish to make a plea for the more extensive and intelligent use of amalgam. In spite of the almost unbelievably bad manner in which this material has been handled and the thorough prejudice which has existed against its use, it has saved more teeth than all other materials combined. It is interesting to speculate on the good that might have been done had it been intelligently and carefully used.

Medico-Dental Building.

ADDITIONAL DATA ON TYPES OF OCCLUSION IN A SAMPLE OF THE AMERICAN POPULATION

By F. L. STANTON, D.D.S., and M. S. GOLDSTEIN, Ph.D., New York City

IN a previous report,[1] we presented the incidence of various types of occlusion at annual periods from two to twelve years of age. Recently, other data were obtained on this question, between the ages of three and twenty-one years. This new material is the substance for the present contribution. Aside from the additional information that the data may contribute, in view of the much greater age range, the paper should also prove of interest as a check on our own previous work as well as on similar work of other authors.

MATERIAL AND METHOD

Fifty subjects were observed at each age period, beginning at 2½ to 3½ years and proceeding at biannual intervals up to and including 20½ to 21½ years. (At some ages, observations on dental occlusion slightly exceeded or were less than the cited fifty.) The subjects were males and preponderantly Jewish. For further details regarding material, reference may be had to a previous work.[2]

The matter of definition with regard to normal and abnormal occlusion, as it appears to us, has been fully dealt with in the first mentioned paper,[1] and the details need not be repeated. It will suffice to say that the criteria of occlusion were, first, essentially according to Angle and, second, with regard to local "bite." The classification of the occlusion was in all cases made by the first author (F. L. S.).

VARIOUS TYPES OF OCCLUSION

Table 1 presents the data according to age and type of occlusion. The number of cases after subdivision into various occlusion classes becomes rather small in any single category. Nevertheless, several points are disclosed which occur both in our previous study and in an excellent contribution to the subject published in Australia by Taylor.[3]

First, we note a sharp decline in abnormal occlusion between three and five years, obviously intimating a tendency toward improvement or correction of malocclusion at this time, a matter of pertinent interest to the orthodontist. Indeed, there is a suggestion of just such a condition also between nine and eleven years and even between eleven and thirteen years. What is more, precisely these conditions were evident in our previous study,[1] made on a totally different group of children. In the latter work (p. 552), the incidence of malocclusion drops from 55.6 to 45.4 per cent between two and three years, and is 43.0 per cent both at four and at five years, and, as in the present data, rises sharply immediately thereafter, being 57.0 per cent at six years.

(From the Division of Child Research, New York University College of Dentistry.)

(This is one of a series of researches to which the U. S. Works Progress Administration contributed substantially in clerical help. This aid is gratefully acknowledged.)

Taylor's data do not lend themselves to analysis on this point; namely, the trend toward improvement of occlusion between two or three and five years.

The second item which we consider of special interest is the fluctuation and actual reduction in relative frequency, at certain ages, of Angle's Class II type of malocclusion. We realize that it is sheer heresy to even intimate that a Class II type of malocclusion can show improvement, perhaps moving into the Class I category, or can even be substantially corrected, without orthodontic treatment. Yet the evidence certainly suggests just that condition. This phenomenon was noted in our previous study; and, despite a rather erratic distribution or incidence of Class II cases, in the present data the same trend is clear; namely, a diminution in prevalence of this type of malocclusion between three and about thirteen years of age.

Furthermore, in Taylor's study of Australian children,[3] we find (p. 651) that the incidence of Class II in children under six years is 30.1 per cent (of all cases of malocclusion) and in children over six years (up to twelve years) is 8.1 per cent, precisely the situation noted in our studies.*

At this juncture, it may be well to

TABLE 1.—DISTRIBUTION OF NORMAL AND ABNORMAL OCCLUSION BETWEEN THREE AND TWENTY-ONE YEARS OF AGE

		Age (Years)									
Occlusion		3	5	7	9	11	13	15	17	19	21
Normal	No.	12	26	16	4	11	12	12	13	14	14
	%	25.5	53.1	32.0	8.0	18.6	24.5	24.0	25.5	28.0	28.0
Abnormal	No.	35	23	34	46	48	37	38	38	36	36
	%	74.5	46.9	68.0	92.0	81.4	75.5	76.0	74.5	72.0	72.0
Abnormal											
Class I	No.	35	21	34	45	46	35	31	31	32	31
	%	100.0	91.3	100.0	97.8	95.8	94.6	81.6	81.6	88.9	86.1
Class II	No.	.....	2	.....	....	2	2	7	6	1	4
	%		8.7			4.2	5.4	18.4	15.8	2.8	11.1
Class III	No.	.....		.....	1	.....	....	....	1	3	1
	%				2.2				2.6	8.3	2.8
Class II											
Division I	No.	.....	2			2	1	6	5	1	3
	%		100.0			100.0	50.0	85.7	83.3	100.0	75.0
Division II	No.	.....	.....			.....	1	1	1	.....	1
	%						50.0	14.3	16.7		25.0

*Reference to Taylor's original data discloses an inadvertent error between the totals of the itemized figures in Table IXB and the gross totals in Table IXC (p. 651).

Dr. Taylor has very generously replied to our inquiry on this matter as follows: "It was obviously [the error] due to the fact that I included a group of seventeen children (of the Masonic school survey) in the gross totals, these children being the first group examined on the morning that I was sizing up the possibilities of work in the institution in question. I did not have my record cards printed nor full examination started until the subsequent visit." In other words, the figures quoted by us, referring to type of occlusion with regard to age and sex, are correct.

point out that, although the figures or percentages in the several studies cited may not be exactly alike in every instance, the really significant fact is that the trends, or variations in types of occlusion at certain ages, are markedly similar. As a matter of fact, our figures are really substantially like Taylor's and those of Korkhaus[4] in many respects, probably as much so as could be expected in samples of different size, ethnic origin and perhaps social status.

Figures 1 and 2, showing the same patients at different ages, demonstrate that a Class II type of malocclusion can improve without treatment.

In Table 2, we have divided our data according to deciduous dentition (three to five years), transitional dentition (seven to thirteen years) and permanent dentition (fifteen to twenty-one years), thereby attaining larger numbers in the various classes and consequently enhancing the reliability of the results.

The results are extremely interesting. Abnormal occlusion is seen to be most prevalent during the transition from deciduous to permanent teeth (seven to thirteen years). The incidence in the completely permanent dentition, although somewhat less than in the transitional stage, is still much greater than in the deciduous period.

Of special interest are the fluctuations in types of malocclusion during these periods. The frequency of Class I drops sharply in the permanent dentition, as compared either with conditions in the deciduous stages or with those present in the transitional stages. At the same time, Class II, or even Class III, increases markedly in prevalence during the full permanent dentition period.

Table 3 is based on Taylor's figures. In Group B, the incidence of malocclusion is much greater in children between six and twelve years, our transitional stage, than in the preceding period of "under six years." Likewise, in Group A, the transitional stage (six to twelve years) manifests an extremely high incidence of malocclusion, much more so than was noted in the deciduous stage (Group B) or in the permanent dentition (over twelve years). The incidence of malocclusion in the permanent dentition is nevertheless still higher than in the deciduous period.

This situation is exactly like that observed in our data.

Regarding types of malocclusion, we note in Group B and in the boys of

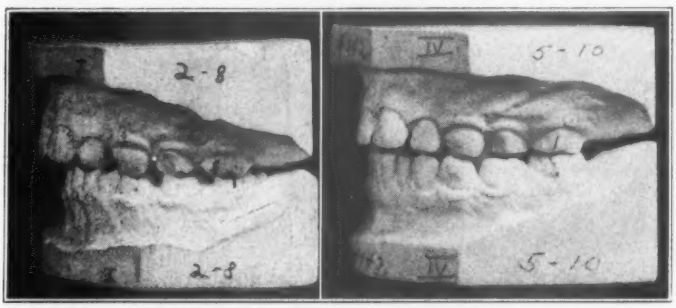

Fig. 1.—Class II malocclusion manifesting substantial improvement without any orthodontic treatment, in a girl at two years, eight months and at five years, ten months.

Group A that the incidence of Class I is greatest in the transitional period (six to twelve years) and distinctly less in the permanent dentition, but the latter is still higher than in the deciduous dentition; all of which is identical with conditions observed in our material. But of special interest is the behavior of Class II malocclusion. A marked drop in relative incidence occurs in the transitional stage as compared with the deciduous (Group B), and although the percentage of Class II malocclusion in the transitional stage in Group A (boys) is much higher than in the transitional period in Group B, it is still much less than occurs in the deciduous dentition. Furthermore, the incidence increases substantially in the permanent dentition. These relationships likewise are quite similar to conditions noted in our data (Table 2). The girls, it may be observed, do not altogether follow this pattern.

To summarize and interpret the preceding: With the initial eruption of teeth, whether deciduous or permanent, there is apparently a decided tendency or susceptibility to malocclusion, and this appears especially true in the permanent dentition or during the transition from deciduous to permanent teeth. Shortly after complete eruption of, first, the deciduous teeth and, second, the permanent teeth, the occlusion evidently tends to improve, or even to be corrected, without any artificial treatment. Indeed, these facts would tend to support the contention that, generally speaking, no extensive orthodontic treatment should be carried out during the deciduous dentition or even in the period of transition from deciduous to permanent teeth.

With regard to type of occlusion, it is, curiously enough, Class I which increases in prevalence during the transitional period, while Class II is actually diminishing in frequency. In the full permanent dentition, it is the Class I group which now manifests improvement and Class II which increases in prevalence.

It is evident why, during the period of tooth eruption, there should be a tendency to rotation of the teeth, or even a general disturbance in the dental alinement (Class I), which subsequently, perhaps by force of occlusion or elimination of certain habits (thumbsucking, etc.), would be corrected. But it is not altogether clear why the Class II type

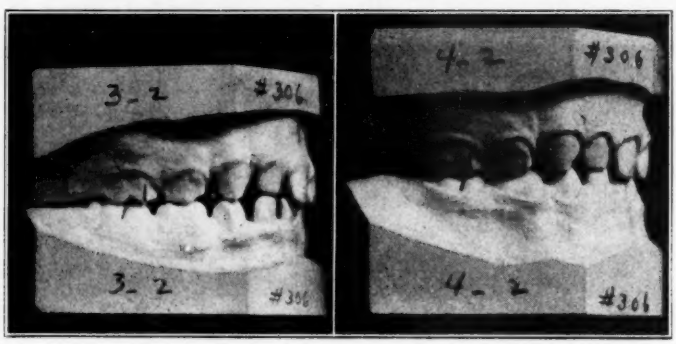

Fig. 2.—Class II malocclusion manifesting substantial improvement without any orthodontic treatment, in a boy at three years, two months and at four years, four months.

of malocclusion should first show improvement in the deciduous dentition and later in the transitional period and, in the permanent dentition, should manifest a relatively sharp rise in incidence. In this connection, it may be well to recall that the severity of the malocclusion (Class II), in terms of degree of horizontal overbite in the incisor region, actually increases between two and nine years of age.[1]

CLASSIFICATION OF BITE

The "bite," as defined by us previously,[1] refers to the kind of interrelationship of the maxillary and mandibular teeth in local sections of the dental arch. In the present instance, we shall consider the incidence of the various types of bite both in normal occlusion and the several Angle classes of malocclusion, and with reference to the deciduous dentition (three to five years), the transitional dentition (seven to thirteen years) and the permanent dentition (fifteen to twenty-one years). This is done in Table 4.

A number of exceedingly interesting and suggestive trends are noted. The incidence of normal occlusion is not only relatively high in the deciduous dentition, but the anterior bite is preponderantly good, as well. Indeed, this condition is all the more striking in contrast with the situation in the transitional dentition. Here, normal occlusion is much rarer, as already noted, and even in normal occlusion there is a tendency to poor anterior bite, this condition being practically as common at this time as good bite. Mention may be made that poor bite in normal occlusion refers primarily to the anterior overbite, tending to excess horizontally (up to 3 mm.) and vertically, yet not to an extent which could be considered abnormal or a malocclusion.

TABLE 2.—DISTRIBUTION OF NORMAL AND ABNORMAL OCCLUSION ACCORDING TO TYPE OF DENTITION*

Age Years		Normal	Abnormal	Class I	Class II Total	Class III	Class II	
							Div. I	Div. II
3–5	No.	38	58	56	2		2	
	%	39.6	60.4	96.6	3.4	..	100.0	
7–13	No.	43	165	160	4	1	3	1
	%	20.7	79.3	97.0	2.4	0.6	75.0	25.0
15–21	No.	53	148	125	18	5	15	3
	%	26.4	73.4	84.5	12.2	3.3	83.3	16.7

*Deciduous, 3-5 years; transitional, 7-13 years; permanent, 15-21 years.

To revert to the tendency toward excessive overbite in normal occlusion: We note that in the group showing excessive overbite in malocclusion, especially of the Class I type, there is actually an appreciable increase in the transitional stage, probably because many with poor bite overlap into one of the "excess" category, under malocclusion. But all of this is apparently a temporary condition. In the permanent dentition, persons with normal occlusion usually again have a good anterior bite, and the incidence of excess overbite of the Class I type is now sharply reduced.

The functioning of the good bite in malocclusion is quite interesting. It is recalled that this classification refers chiefly to cases in which teeth are prematurely missing, but the anterior bite is not materially affected. In the deciduous dentition, such cases are relatively negligible. On the other hand, between seven and thirteen years, the incidence has increased more than tenfold. In other words, rotation and particularly premature loss of teeth are now prevalent and, indeed, become even more prevalent in the permanent dentition.

of elimination of the thumbsucking habit by about the fifth year. In an interesting paper on the subject of thumbsucking and attendant dental malocclusion, Lewis[5] states that breaking the habit by the fifth year "tends" to be accompanied by natural correction of any existing malocclusion apparently caused by the thumbsucking.

Open-bite of the molar region is relatively rare at any time.

The edge-to-edge bite of the incisors does not occur in the deciduous dentition of our group, perhaps as a result of in-

TABLE 3.—INCIDENCE OF MALOCCLUSION IN AUSTRALIAN CHILDREN*

	Age Years	Total Malocclusion Per Cent	Class I Per Cent	Class II Per Cent	Class III Per Cent
Group B†					
Under 6	(162)	57.4	65.6	30.1	4.3
6–12	(143)	86.7	87.1	8.1	4.8
Group A‡					
Boys: 6–12	(109)	90.8	81.8	16.2	2.0
12–15	(71)	66.2	74.5	23.4	2.1
Girls: 6–12	(59)	91.5	63.0	31.5	5.5
12–15	(58)	67.2	79.5	15.4	5.1

*Computed from data presented by Taylor in the Dental Journal of Australia, October 1, 1935.
†Unselected children in the Outpatient Department of the Royal Alexandra Hospital for Children, Sydney.
‡Children at the William Thompson Masonic School, Baulkham Hills.

Open-bite I refers to the incisor region; open-bite II, to the molars. It may be mentioned that excess horizontal overbite was not infrequently manifested at the same time as the open-bite. All such cases were counted in the open-bite category only. The relatively high incidence of this type (I) of malocclusion in the deciduous dentition is without doubt in most instances the direct consequence of thumbsucking. Likewise, the subsequent sharp drop in the frequency of open-bite in the transitional and permanent dentitions is undoubtedly the result

sufficient sampling. Nevertheless, its total absence at this time, and indeed the relatively few cases in the transitional or permanent dentition, seem to indicate that this form of malocclusion is quite rare, and especially so in the deciduous dentition. That there is a somewhat higher incidence of edge-to-edge bite in the transitional than in the permanent dentition may be due to inclusion of cases with permanent incisors not yet fully erupted at the time of observation and meeting, temporarily, edge to edge.

The cross-bite refers to the side teeth

(although the incisors might also be affected), in which the lower teeth, usually on one side, "cross over" beyond the corresponding teeth of the upper arch. This type of malocclusion is often caused by pressure on one side of the jaws, as a result of sleeping on the fist, for example. It is not a frequent type of malocclusion in our material, although it seems to be more common in the permanent dentition than in the deciduous or transitional periods.

Retrusive bite comprises cases with lower incisors protruding more or less in front of the upper incisors, a condition usually associated with Angle's Class III type of malocclusion. We find, however, that this retrusive bite occurs in the Class I category (the side teeth not being affected), being about equally represented in all dentitions. Furthermore, it is apparently more common as a Class I form of malocclusion than as a Class III type.

TABLE 4.—PERCENTILE DISTRIBUTION OF TYPES OF BITE WITH REFERENCE TO OCCLUSION AND AGE*

Occlusion	Bite	Age (Years) 3–5	7–13	15–21
		96	208	201
Normal				
	Good	35.4	10.6	23.4
	Poor	4.2	10.1	3.0
Class I				
	Good, anteriorly	2.1	22.1	32.8
	Excess overbite	35.4	41.9	18.5
	Open-bite I	16.7	3.9	2.5
	Open-bite II	....	0.5	0.5
	Edge-to-edge	....	4.3	2.5
	Cross-bite	2.1	0.5	3.0
	Retrusive	2.1	3.8	2.5
Class II				
	Good, anteriorly	....	....	3.5
	Excess overbite	2.0	1.9	5.0
	Open I	....	....	0.5
Class III				
	Good, anteriorly	....	....	0.5
	Open-bite I	....	....	1.5
	Retrusive	....	0.5	....

*1. Good bite in normal occlusion signifies that the anterior horizontal and vertical overbite of the upper incisors is in excellent relationship with the lower. In malocclusion, this relationship is only slightly, if at all, affected. Rotation and premature loss of teeth, especially the latter, characterize this bite in malocclusion. 2. Poor bite in normal occlusion has reference to too much overbite, horizontal or vertical, yet not enough to classify as malocclusion. 3. Excess overbite refers to the upper incisors protruding beyond or overlapping excessively the lower incisors. 4. Open-bite I refers to the incisor region; open-bite II to the molar region. 5. Edge-to-edge refers to the central incisors. 6. Cross-bite is the condition in which the buccal cusps of upper teeth are lingually to corresponding cusps of the lower teeth. 7. Retrusive bite refers to the protrusion of the lower central incisors in front of the upper central incisors.

Our Class III cases are very few, and it may be recalled that this form of malocclusion actually is relatively rare in the general population. Our material reveals one person with a Class III malocclusion who, nevertheless, possesses a good anterior bite. Also, we find that instead of retrusive bite being typical of Class III, open-bite of the incisors and in the permanent dentition is actually more prevalent, at least in the present sample of the population. It is quite possible that in these cases with open-bite, if the anterior teeth were brought together, the upper incisors might fall inside the lower.

Class II malocclusion too is of considerable interest. In both the deciduous and the transitional dentition, and in practically equal proportions in each, Class II is represented 100 per cent by excess overbite. In our previous study,[1] we note other types of bite in Class II, but we observe also that excess horizontal and vertical overbite predominates. In the permanent dentition (which was not available in the former study), other types of bite appear, a sizable number with good anterior bite, notwithstanding the disturbed posterior relationship. On the other hand, the prevailing type is still an excess overbite, which is in fact now more common than in either the deciduous or the transitional dentition.

CONCLUSIONS

Additional information is presented on types of dental occlusion observed among 505 males at biannual periods between three and twenty-one years of age, with the following conclusions:

1. Malocclusion was present, and not infrequently in the deciduous dentition. In fact, the incidence was higher at three years than at four or five years of age, although again sharply rising at seven years. This phenomenon confirms a similar trend noted by us in a preceding study. A suggested interpretation of this relatively high incidence at three years is that it is due primarily to that prevalent habit of infancy, namely, thumb-sucking, which by the fourth and fifth years becomes increasingly less habitual in most cases, with a corresponding general improvement of occlusion.

2. There is a diminution in frequency of Class II malocclusion between three and about thirteen years, corroborating the same trend noted in our previous study and, indeed, confirmed by observations on Australian children.

3. Malocclusion is most prevalent in the transitional dentition, probably as a result of the rigors of tooth eruption (permanent teeth). The incidence in the permanent dentition is still much higher than in the deciduous dentition.

4. Angle's Class I type of malocclusion is much less common in the permanent dentition than it is in either the deciduous or the transitional period. Both Class II and Class III forms markedly increase in relative incidence during the permanent dentition. The trends noted in paragraphs 3 and 4 substantially agree with the data on Australian children.

5. Occlusion was further classified according to the kind of "bite" manifested in local sections of the dental arches, and with reference to the presence of deciduous, transitional or permanent dentition. The results were as follows:

(a) Normal occlusion, in both the deciduous and the permanent dentition, manifests a preponderance of good anterior bite. In the transitional period, a poor anterior bite, albeit normal occlusion, is almost as common as a good bite.

(b) Excess overbite (horizontal and vertical) in Class I is relatively prevalent in all dentition periods, but more so in the transitional stage than at any other time, many of the poor normal bite

cases perhaps overlapping into the malocclusion category at this time. Also, excess overbite is markedly less frequent in the permanent dentition than in the deciduous or transitional periods.

(c) Good bite in malocclusion, referring chiefly to cases with prematurely lost teeth, is infrequent in the deciduous dentition, but is increasingly common in the transitional and the permanent dentition.

(d) Open-bite of the incisors manifests a relatively high frequency in the deciduous dentition, probably as a result of the thumbsucking habit. In the transitional stage, the incidence has decreased to one fourth, and in the permanent dentition, to one sixth, no doubt as a result of the usual elimination of the habit about the fifth year.

(e) Edge-to-edge bite of the incisors appears to be rare at any time, and especially in the deciduous dentition.

(f) Cross-bite is more common in the permanent than in the deciduous or the transitional dentition, but is not a frequent type, apparently, at any time.

(g) Retrusive bite, the lower incisors protruding in front of the upper, is more common as a Class I manifestation than as a Class III. It appears in about equal proportions in deciduous, transitional and permanent dentitions.

(h) Class III exhibits more open-bite cases than retrusive bite, although a closing of the open-bite might show the lower incisors outside the upper. One good bite case indicates that good anterior bite is not impossible in Class III malocclusion. The evidence suggests that Class III is definitely more common in the permanent dentition than in the preceding periods, but is relatively infrequent in the general population at any time.

(i) Class II malocclusion is distinguished by excess overbite in the deciduous and the transitional dentition. Excess overbite is also preponderantly typical in the permanent dentition. Good anterior bite may occur as a result of posterior disturbance of a Class II type; especially, it seems, in the permanent dentition. With the general increase of Class II malocclusion in the permanent dentition, there is a doubling, and more, of the incidence of excess overbite as compared with conditions in the preceding dentition stages.

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THE RELATION OF METABOLIC DISEASES TO DENTISTRY

By ROBERT W. KEETON, M.D., Chicago, Ill.

IT is my purpose to consider advances in our knowledge of metabolic diseases which are related to the field of dentistry.

The history of medicine furnishes many object lessons of long and fruitless attempts to solve specific problems. Interest in them is seen to wane and at times to disappear completely. Then the general frontier of knowledge is advanced. It rolls forward and literally engulfs these specific problems, harmonizing them with the broad base of new knowledge. The problem becomes a specific illustration of a general process and its solution is clear.

This constitutes my excuse for talking of calcium metabolism, the physiology of the vitamins and the importance of serum proteins. When the physiologist and the biochemist know more about these, there will be less difficulty in understanding caries and degeneration in the gums.

CALCIUM METABOLISM AND CALCIFICATION

Absorption of Calcium.—Of the calcium ingested, 65 to 75 per cent is excreted in the feces. Only 25 to 35 per cent appears in the urine. Although some of the calcium absorbed is again excreted into the bowel, a large part of it passes through the intestines as insoluble salts (carbonates, phosphates and soaps). An intake of 0.45 gm. of calcium a day is required to maintain a normal person in equilibrium. This can be secured from 1 pint of milk (0.56 gm.) and a serving (30 gm.) of some kind of cheese (0.2 gm.). If it is desired to increase the intake sharply, as in the case of children or pregnant women, an additional 100 gm. (one-half cup) of cottage cheese, containing 0.5 to 1.0 gm., may be given.

Absorption is favored by conditions which keep the calcium in solution. A normal gastric acidity facilitates absorption. The absence of free acid from the stomach *(achylia gastrica)* and the administration of alkaline powders, as is customary in ulcers, retard absorption.

In patients suffering from diarrhea, calcium is swept out before there is an opportunity for absorption. In a small group of patients suffering from "celiac disease" or idiopathic steatorrhea, there is a loss of ability of the bowel to absorb fatty acids. After the neutral fat has been saponified through digestion, the fatty acids are neutralized by the intestinal calcium forming soaps. As the quantity present in the food is often insufficient, additional supplies are requisitioned from the body, and demineralization of the bones results.

Vitamin D.—Even when none of the foregoing factors appears to be operative, it is found that bone formation may still fail because sufficient quantities of calcium and phosphorus are not absorbed. The patient is healthy in all other respects. It has been found that this can be

(From the Department of Medicine, University of Illinois College of Medicine.)

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corrected by the administration of vitamin D. The rapidity with which studies in vitamin D have progressed and the large number of data accumulated have led to some confusion. For clarity, I shall emphasize a few of the helpful conclusions from these studies:

1. The activity of vitamin D is due to a variety of substances which are closely related in structure and belong to the class "animal sterols." Besides variations in structure, there is a wide difference in concentrations in various animals. Thus the tuna fish liver yields an oil containing 40,000 international units; whereas, the oil from codfish liver yields only 100 units. These compounds play no rôle in plant physiology. As they are not found in live plant tissues, the vegetables of the diet and the vegetable oils do not supply vitamin D. The concentration in milk and butter is so low as to exclude these as practical sources.

2. In 1924, Hess and Steenbock independently and almost simultaneously announced the discovery that exposure of edible materials to ultraviolet light endows them with anti-rachitic properties. Shortly afterward, the present method of irradiating ergosterol was perfected and this substance came to be spoken of as provitamin D. In the process of irradiation, several products are formed, one of which, known as calciferol, has been isolated and identified as vitamin D. At least one of the products, toxisterol, substance 248, may be produced by prolonged or excessive irradiation. This substance is toxic and lacks anti-rachitic properties. When vitamin D originating from irradiation is compared with that derived from the livers of fish, a difference in the healing effect in rickets is found. When the same number of international units are used, the natural product is three times more effective than the irradiation product.

3. Vitamin D may be produced by irradiating the skin of the patient. The products of irradiation are transported through the blood stream and become available when needed. In view of the toxic substances produced by irradiation outside the body, one wonders whether caution should not be exercised in exposing the body to the sun during the summer months. The deep sun tan may not be acquired entirely without danger.

4. Vitamin D products of a potency forty times the customary strength have been used in experimental work during the last few years. When these are given over a period of time, toxic symptoms appear; but these symptoms disappear in seven to fourteen days after the drug is discontinued.

5. In ordinary therapeutic doses, vitamin D facilitates absorption of calcium and phosphates from the intestines. When the dose is somewhat larger, the calcium and phosphorus of the blood may be increased more than would be predicted from the intestinal absorption. This means that the tissues are yielding the supplies. Phosphate can be obtained from the body lipids. Calcium can be secured from areas of pathologic calcification and from the bones. With such doses, larger quantities of calcium are excreted through the urine. Theoretically, activation of a tuberculosis from decalcifying a gland might occur. The formation of a kidney stone from excess calcium held in solution in the urine is also possible.

TRANSPORT OF CALCIUM IN BLOOD

McLean and associates have shown that calcium exists in combination with the serum proteins and in the ionized state Ca^{++}. With normal values for serum proteins and total calcium, the calcium is about equally distributed. The ionized calcium is of great physiologic and clinical importance. Thus, if the protein is kept constant, the total blood calcium

and consequently the ionized calcium may be increased by the administration of parathyroid extract or large doses of vitamin D. Then it may be lowered by removing the parathyroids or by stopping the intake of calcium through calcium starvation or poor absorption.

If phosphates are added to the serum, a colloidal compound of calcium phosphate is formed. This is rapidly removed from the blood stream (F. C. McLean), reduction in the calcium resulting.

CALCIFICATION

Rickets is a disease in which there is an interruption to the normal calcification of bone. When calcification becomes normal, healing occurs. If this process could be understood, we would have a solution of the mechanism. Howland and Kramer noted that in rickets the calcium was often normal, but the phosphorus was low; and if the phosphorus was normal, the calcium was likely to be low. The product of Ca×P expressed in milligrams per hundred cubic centimeters of serum was below normal. It was further shown that if ossifying cartilage was placed in normal serum or in an inorganic salt solution of proper calcium and phosphorus content, calcification occurred. If it was placed in a rachitic serum or one low in phosphorus, calcification did not occur. The difficulty in rickets then seems to lie in the blood serum. McLean has noted that when phosphate is added to blood serum, a colloidal compound of calcium phosphate is formed. This is at once removed from the blood stream. He and R. H. McCoy have further shown that in rachitic rats the removal of this compound is associated with a deposition of calcium phosphate in the cartilage. In other words, calcification is induced.

What, then, is learned from these studies of rickets relative to calcification? Vitamin D furnished to a child with rickets promotes the absorption of phosphorus and restores to normal the concentration of calcium and phosphorus in the blood. The cartilage is now able to secure from this medium a colloidal compound of calcium phosphate, which is deposited as bone.

We may next ask ourselves: How is this compound formed in the cartilage? Why does it not form in the muscles or elsewhere? The ossification of cartilage *in vitro* (Shipley, P. G., Kramer, B., and Howland, J.) is entirely prevented by protoplasmic poisons such as potassium cyanide. Robinson and associates have demonstrated an enzyme in cartilage, phosphoric esterase or phosphatase, which acts on the acid soluble organic phosphorus compounds of blood, releasing free phosphoric acid. This would increase the concentration phosphate ions locally with a precipitate of colloidal tricalcium phosphate. This enzyme appears in bone at the time calcification begins. It is also present in teeth of growing rats. There is much evidence (Kay, H. D.) that its action is reversible. It may be an agent responsible for demineralization as well as calcification. Its rate of action may be altered. Toxic agents may destroy it. It can be readily seen that the phosphatase of the tooth might be quite susceptible to damage.

From this brief survey of the mechanism of calcification, it is clear that there are many points of vulnerability in it. It is not surprising, therefore, that those investigators who have sought for the solution of caries in a break down of one or another factors have found it. One would expect that anything which interferes with the process as a whole would lead to caries. Hence, there should be multiple etiologic factors found.

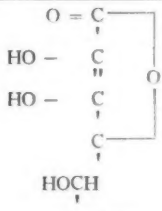
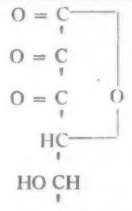
VITAMIN C (CEVITAMIC ACID)

Structure.—The chemical structure of

vitamin C has been recently determined and it is now produced synthetically on a commercial scale. It exists in the tissues in a reduced form l-ascorbic acid, or cevitamic acid, and readily passes by oxidation to dehydro-ascorbic acid. The latter is easily reversible through reduction to the original form.

Distribution.—Vitamin C is found in practically all the tissues of the body, the greatest concentration being found in the suprarenal glands and glandular tissues in general, the lowest concentrations in muscles and stored fat. Cancer cells contain larger than normal amounts. In the plant, it occurs in all rapidly growing stems and root tips, buds, green leaves, seeds and pods. It is also found in citrus fruits, paprikas and tomatoes and in other plants where red, green and yellow pigments exist. During the last year, we have been studying the requirements of the body for this vitamin and have found that in patients suffering from hyperthyroidism with accelerated metabolic rates, the utilization is greater than normal. In patients with actively growing cancers, the requirements are increased. In scurvy, there is a deficiency and it has been found that the ability of the tissues to utilize oxygen is less than normal.

Function.—From a consideration of the structure, its behavior toward oxidizing and reducing agents and its distribution, this vitamin has come to be regarded as a catalyst which controls cellular oxidation and respiration. The local requirements of any tissue will be governed by its metabolic status. If active growth is in progress or the tissue is undergoing repair from previous damage, the requirements will be greater than if the tissue were undergoing normal replacement from the daily factors of wear and tear. This view is supported by the experimental studies of Hanke, who found that children who were below standard height and weight for normal children rapidly attained these standards when large quantities of vitamin C were added to their diets.

Vitamin C		Reversibly oxidized form
	(H_2O_2) $-2H$ ⟶ ⟵ $+2H$ (H_2S)	
1 — ascorbic acid		dehydro-ascorbic acid

The second function of vitamin C as shown by S. B. Wolbach and Percy R. Howe is regulation of the colloidal condition of intercellular substances. Thus, in scurvy, we find swollen, edematous bleeding gums. The blood extravasates between the capillary cells and remains in the lymph and extra-cellular spaces. We see much the same condition in gingivitis of undetermined etiology. The physician tests this function of capillary integrity by obstructing the venous return from the arm and allowing the arterial blood to enter it. If after five minutes there are minute hemorrhages in the obstructed area, there is capillary fragility. The ad-

ministration of vitamin C will often overcome this condition.

It should be quite evident that the use of large quantities of vitamin C is indicated in cases of diseased or unhealthy gum tissue. It has become a routine practice with me now to saturate my patients with cevitamic acid before they are sent to the dentist for extractions. The effect on healing is striking. The average normal person will become saturated in four to five days on 400 mg. a day given by mouth.

The data in the literature (Day, Fish and Harris, Hanke), indicating that addition of large doses of vitamin C to the diet will prevent the onset of caries in the young and, after it has begun, arrest it, have not been so easily interpreted. However, if one considers the rôle of the vitamin in cellular respiration and oxidation, there is a definite basis for the observations. There is no reason to doubt that the live tooth requires a supply of oxygen to remain alive.

SERUM PROTEINS

The circulatory system is a closed system of vessels within which a variable pressure exists. This pressure within the arteries, arterioles and capillaries is a positive one. Hence, there is always a stress applied against the vascular walls. If this is not opposed or balanced in some manner, the fluids will filter into the tissue spaces. The serum proteins amount in the normal person to 7 per cent. When the osmotic pressure of the proteins is measured, it is found to be 30 mm.Hg. This pressure tends to attract water from the tissues into the vessels and so opposes the hydrostatic pressure which is exerted on the blood. Hence, in the normal person, there is a balance in these opposing factors and little or no fluid escapes from the capillary walls. If, owing to disease and other conditions, there is a lowering of the concentration to 4 per cent or less, the osmotic pressure developed is less than the hydrostatic pressure. Fluids pass out through the vessel walls and a state of edema exists. We frequently see this condition. It is obvious that it would interfere with the necessary exchange of water, solutes and oxygen. Hence, it would be expected to be attended by a degeneration of the gums and an advancing caries. Experience has confirmed these predictions.

The lowering of the serum proteins occurs in patients who have been deprived of adequate quantities of protein over long periods of time. This is spoken of as nutritional edema. Since the condition was not uncommon in the World War, it was called "war edema." We still find patients with psychoneuroses who have restricted their protein to the starvation level. Then there are persons, suffering from chronic gastro-intestinal disease and other wasting diseases, who have had an inadequate intake of food, and they show this type of edema.

In disorders of the kidney, there may be a larger loss of albumin in the urine, and this may not be replaced by the diet. The serum proteins are apparently formed in the liver. Patients suffering from various types of liver disease, especially cirrhosis, are unable to synthesize the proteins, and so the quantities in the blood fall below the normal limit, and they develop edema.

CONCLUSIONS

Time does not permit a complete survey of all the nutritional factors concerned in the maintenance of health. Three different factors which produce their effects through different mechanisms have been selected as illustrations.

1. The mechanism of calcification was presented and it was evident that there are four vulnerable points: (a) the diet,

(b) the intestines, the site of absorption, (c) the blood, the transport agent, and (d) the bone, the site of salt deposition and bone formation.

2. Vitamin C is a catalyst responsible for cellular respiration and an agent which exerts a profound influence on the colloidal intercellular substance.

3. The serum proteins, through their osmotic pressure, confine the blood to the vessels and prevent the development of edema.

The dentist is dealing with tissues in the mouth. They are subject to the same physiologic and biochemical laws as tissues in stomach and kidney. When disease strikes the mouth tissues, the manifestations may be different, but the laws responsible for the decay and recovery of these tissues are those operative in other body tissues.

It is evident, therefore, that the dentist must take his place by the side of the physician and become a student of biology.

8 South Michigan Avenue.

THE PROBLEM OF TOOTH COLOR

By J. E. ARGUE, D.D.S., Seattle, Wash.

THE problem of tooth color requires the employment of fundamentals, correctly applied, and experience in matching the colors of the teeth. Our ideal should be to copy the work of Nature, analyzing the construction of the human teeth in order to get a conception of how the tooth color is produced.

The colors are principally deep underlying colors contained in the dentin, which gives the body color to the teeth. The enamel, a transparent substance containing very little color, covers the entire crown portion of the dentin, and the light passing through it reflects in varying degree the colors that lie principally within the mass of dentin.

The result is, of course, influenced by the surface colorings which may be on the enamel, and which, when combined, give detail to the tooth color. The color arrangement is a very definite gradation from the gingival to the incisal, or occlusal, areas and, being produced by the body color, varies greatly in hue and blend.

This gradation of color varies in different persons and also in the teeth of the same person, the variance being due somewhat to the fact that the different anatomic forms of the teeth present a varied thickness of substance of any given color. A simple example of this can be demonstrated by taking three pieces of yellow glass, the same size and thickness, holding one piece to the light, and, in turn, placing two pieces together, when a much deeper yellow will be noted. If the third piece is also placed in the same position, a still deeper hue will be produced, the degree of any given color varying in ratio to the thickness of the substance.

Teeth must be considered as translucent bodies which transmit, reflect and absorb rays of light in varying degrees. Light phenomena therefore enter the problem, necessitating that the porcelain be given the proper fusion to produce as nearly as possible the same translucency.

(Read before the Section on Partial Dentures—Crown and Bridge at the Seventy-Third Annual Midwinter Clinic of the Chicago Dental Society, February 17, 1937.)

Also, the anatomic form of the mate of a tooth should be identically copied; to produce, first, the thickness of mass, and, second, the same contour of the surface, to influence the rays of light with the same reflection and refraction, in order to effect harmony with the other teeth.

In the construction of porcelain crowns and inlays, we can carefully bake the foundation body porcelain to only a high biscuit, producing an opaque mass to represent dentin and then completing the detailed tooth form with a layer of lower fusing body, and bring this to a glaze, producing a transparent mass to represent the enamel. In a manner, we produce a copy, as nature constructs a human tooth in mass, the transparent enamel reflecting colors of the opaque mass beneath.

The light rays have somewhat the same harmonious effect as that produced with the adjoining teeth, reproducing in a great measure the same effect, apparent to a keen observer, as that of the natural teeth.

A most practical method consists in dividing the tooth surface into, say, gingival, middle and incisal, or occlusal, thirds, studying the color arrangement in these given areas, and determining the colors which should be used to reproduce each separately, and which, when combined in thirds in their proper relation, produce a color blending from the gingival to the occluding portion of the tooth.

The mixing of colors to reproduce any other color is a highly scientific art, and we should have a thorough knowledge of how to mix the different colors and what shade will be produced thereby, as in no other way can we determine what colors to combine and what colors not to combine to obtain the desired color arrangement.

Dental porcelains are now available which make it possible to produce practically all the necessary colors that we find in the natural color arrangement of the teeth; namely, yellow, orange, brown, gray, blue and green, and also pink, to represent the gum tissue color. Therefore, it is not necessary, in building colors, to produce any other color, but what is necessary is to mix different variations of colors, to change a darker shade to a lighter hue of the same color, or vice versa.

In this manner, the degree of the color of any given area, for instance, the gingival, the middle or the incisal, or occlusal, thirds of the tooth, places at our command a broad range from which hundreds of artistic shadings of teeth can be produced.

Then, too, the eye must be trained; first, to recognize the color of any given area of the tooth; second, to modify the color to reproduce the degree of color of a tooth area, and, third, to combine the color arrangement to give the proper gradation from the gingival to the occluding surface, and also to reproduce the deep underlying colors, and the surface colors as the final result.

A record can be made of the shade of each patient's teeth, and this can be filed away for future reference. Also, a more uniform shading can be accomplished when a record is kept. Shading can be done by carefully measuring on the end of the porcelain carving spatula the amount of each shade, by number, to vary the hue of any given area. The comparative ratio is notated by an exponent cipher. (Example: $34-$gingival, $33^{2}+32-$middle, $31^{2}+37-$incisal, or occlusal.) In this way, we have a definite formula for the thirds, denoting the degree and the number of the color of porcelain to be used in any given third.

In selecting shades for the teeth, a careful study should be made as to how the color varies in its arrangement in the

central and lateral incisors, cuspids, bicuspids and molars.

There should be no uniformity in placing the colors, but they should be varied for each tooth in a general way, as follows: In making a detailed study of the colors, it will be found that the upper central incisors have less of the incisal third colors, and the middle third color will necessarily be carried more incisally. The lower four incisors have the same color formation as the upper central incisors.

The upper lateral incisor has a more pronounced incisal color, which, in some cases, runs one-half the length of the tooth gingivo-incisally. Therefore, the areas of both middle and gingival third colors should be shortened. The cuspids have more of the gingival color that runs well into the middle third, with only a shallow area of incisal variation of color.

The bicuspids have a color formation that corresponds closely with that of the lateral incisors, but not quite so pronounced a gingival and occlusal color, and less of the middle third color.

Most important in study of the shade problem is expertness in reproducing the varied shadings of the teeth in the mouth, *i.e.*, the characteristic shade of each individual tooth, as required. When in doubt, I make test bakes of given combinations of shades, as it often saves considerable time. When the shades for the thirds are laid on the slab and moistened with distilled water, a strip of matrix platinum about the width of a central incisor and 15 mm. long is set into the lock pliers, and on this metal are laid the variations of colors to be reproduced, and which, when blended, will give as nearly as possible the color of the particular tooth to be reproduced.

The porcelain is dried out, baked to a high biscuit and cooled, and the platinum is removed. The porcelain is then moistened and compared with the patient's teeth for color. Any correction can then be made, the degree of color of any given third and also the color arrangement being checked.

The full complement of unimpaired teeth, or one that may have been only slightly attacked by caries, so that the color has not been changed to any great extent, makes the ideal study. Discoloration from fillings, principally at the angles, should be considered in building color.

In beginning an operation, it is best to go over the teeth with some extra fine pumice, to clean the surface. This gives an opportunity to see the underlying color in its entirety. In making the study, we look down into the depth of the color; turn the head of the patient so that we can observe the color from all angles, and train the eye to seek out the color in the given areas of the tooth, forming, so to speak, a mental picture of the color arrangement as it should be reproduced and as it should look when completed. It is only with such constructive study that we can assure ideal results.

There are deep underlying colors at various locations in teeth in different persons which are characteristic of the general shade of their teeth, and which can also be artistically reproduced.

Let us take, for example, the dark shadow line running mesio-distally at the junction of the middle third with the incisal, or occlusal, third: This is built in, in the first bake, some dark gray or brown body being used in this given area, extending from the contact point mesially to the contact distally.

When the regular colors are built over this and the enamel body is added and brought to a glaze, the dark colored porcelain is very perceptible and reproduces the dark shadow line in the depth of the body color, which gives the de-

sired color effect. Also, light or dark areas in other locations running mesiodistally, or at the mesial or distal incisal angles, can be taken care of in the same manner.

SURFACE STAINING

When the tooth form has been completed with the foundation body, the platinum matrix is removed and the crown fitted on the prepared tooth. Slight grinding may be necessary on the mesial and distal surfaces so that the crown will go to place on the preparation. With a fine explorer point, the crown is examined for over-hang and then removed, and with a perfectly true three-fourths inch carbodisk, the over-hang is ground off where necessary. By placing the crown on the preparation and testing with the explorer several times, a clean fitting joint is made.

A heatless or a gem stone may be used for necessary corrections of the tooth form and to make the length accord with that of the other teeth.

At approximately the age of thirty to thirty-five years, the enamel on the incisal and occlusal surfaces wears through to the dentin, which soon takes on a stain to a greater or less degree.

These stains should be considered in making the proper shadings in porcelain crown restorations, which is done after the porcelain crown has been ground to form.

A groove is ground on the incisal surface, with a small knife-edge stone, outlining the form and size of the stain. Low-fusing stain of the selected color is placed in the groove and baked. Then, when the enamel body is fused over this, an excellent reproduction is had of the wear and the dentinal stains on these incisal surfaces.

As these effects are more noticeable in the lower incisors and cuspids, the color and form of the stains should be carefully detailed to reproduce as nearly as possible the harmony of the adjoining teeth.

Clouds, checks or staining at the gingival third can be tinted on the surface of the foundation body, then baked before the enamel layer is placed.

Surface staining can be made with stains that fuse at about 2100 degrees. All staining should be done with the patient in the chair, in order to assure a more accurate result.

ENAMEL BODY

Porcelains of the same color, one-fourth of a 1700° fusing point and three-fourths of a 2300° fusing point, when mixed and triturated well together, will fuse at about 2140° in a period of about three minutes.

This makes an ideal enamel body and one that can be fused over the crown or inlay which has been previously built with the 2440° foundation body porcelain, without disturbing the form.

Before the enamel colors are selected, the teeth are dried with compressed air, so that the surface colorings and the detail surface form and markings can be plainly seen, as these should be reproduced in combination with the enamel color. The enamel shading should be selected to correspond with the surface color of the teeth, which requires one, two or, in rare cases, three variations of enamel color.

The enamel body is mixed with moisture in an amount to make it flow nicely, yet hold its form when spatulated. It is placed with the carving spatula and properly condensed on the surface of the crown or inlay by vibration and spatulation.

Placing of the body is first begun at the gingival portion, and it is built from 0.2 to 0.5 mm. thick and carried toward

the occlusal portion, with careful detailing of the surface form of the tooth as we progress, restoring the angles, developmental grooves and contours of the adjoining teeth.

Surface cross lines may be made mesiodistally by the use of the No. 0 brush, after the detail form is completed.

In the baking of this enamel, precaution must be taken not to overbake and produce a high glaze, which would destroy the detail form of the tooth. This is avoided by carefully timing the baking at a certain temperature to reproduce the required smoothness of the enamel surface.

Selecting the shades for the porcelain inlay is much more difficult than selecting those for the porcelain jacket crown.

A more detailed shading is required and, in most cases, a much lighter shade. Use of the enamel body on the surfaces of inlays aids greatly in the harmony of color, and also it produces a surface that can be polished at the margins with cuttlefish disks. When this is carefully done, inlays are of a more finished character.

A few general rules that can be accepted in building the shades for the porcelain inlay and that, in my experience, I have found valuable are as follows:

In Class 3 and 4 cavities, the mesial should be made darker than the distal surfaces because the light rays are more direct and are reflected from the body of the tooth, making it appear lighter, an effect which is reversed on the distal surfaces. Here, the light rays penetrate the tooth to a limited degree and cast the shadow distally, which makes inlays on the distal surfaces look darker. Therefore, it is the rule in these cases to make mesial inlays darker and distal inlays lighter, to give a better matching effect.

In Class 4 cavities, when incisal angles are built, the incisal third of the inlay should be made decidedly darker than the tooth appears, as the light rays here are more direct, with less of the shadow influence.

In Class 5 cavities, the gingival color selected is usually darker than it appears in the tooth, and is shaded with a more abrupt blending to a lighter color incisally or occlusally.

Where porcelain is used in combination with gold, it is always safer to use much lighter shades, and vary them for mesial and distal cavities.

A fundamental principle that is often overlooked concerns the cavity outline. When the preparation is reduced to the minimum, with the proper artistic outline, the shading of the porcelain inlay can be accomplished with much greater ease.

CONCLUSION

I have endeavored to present the shading problem in a practical and concise way, so that it can be clearly understood.

Operators who possess a great deal of natural ability are more successful in building artistic colors. However, if one will diligently train his eyes to become color conscious, with the necessary experience in the fundamentals he should not find it so difficult to produce some very artistic effects in porcelain operations.

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Editorial Department

IF THE GOVERNMENT SHUT DOWN

There is one department of our Federal Government which does its work so quietly and unostentatiously that few of our citizens ever take the trouble to study its operations sufficiently to gain a clear conception of its workings, or in fact ever pay much attention to it at all.

Yet this activity of our Government is responsible for safe-guarding the welfare of the citizen in one of the most important particulars of his everyday life. Were it not for this department, the citizens of our country would be subjected to more abuse and greater danger than can possibly be realized by the average person. This activity of the Government relates to the regulation of the Food and Drug Act, the ramifications of which reach out to affect the citizen in a very intimate and important particular.

Human nature being what it is, the probabilities are that were it not for the regulations of the Government, the abuses that would be

perpetrated on the public would be little short of appalling. The exploitation of the people would be permitted to proceed to the infinite detriment of the public, and not till such time as the people began to die in sufficient numbers to create a public sensation would the poisoning from pernicious drugs and impure foods be brought to the attention of the populace.

When the power of money is used to exploit the people, there is no other agency so effective as government control to hold the rod over the exploiters, and consequently if for any reason the Government were suddenly to shut down and cease operations, the extent of exploitation and general demoralization would be well nigh indescribable.

Yet it appears to be only human nature for many of our citizens to chafe under government restraint, and to openly resist legitimate governmental regulation. Too frequently, the citizen considers it smart practice to try to hoodwink the constituted authorities, and, in the vernacular, try to "put one over on them," apparently little realizing that this same sharp practice is definitely detrimental to public welfare, as well as to the individual citizen himself. It is merely a clear case of the Government employing every means in its power to protect the citizen against himself, and while this must logically be accounted a thankless task, the attitude of the citizen seems to be merely a typical manifestation of human nature.

How quickly the hordes of the enemy would be turned loose on the public if the Government should relax its vigilance for one moment! Sometimes it would seem that the people love to be fooled, but when the fooling results in anything as definitely damaging as introducing poisonous material into the human economy, the perniciousness of such a practice cannot be ignored. If the people will never learn to protect themselves, it is manifest that the Government must institute measures to see that protection is forced on them, and it sometimes seems that greater energy and ingenuity were required to afford protection against ulterior influences than to institute such measures as have for their sole object those constructive agencies concerned in invention or the promulgation of new discoveries.

All along the line of human endeavor, the battle lines of progress are posed in serried ranks, and fortunate it is that Government, in

its beneficence, is ranged with the powers that fight for the health and happiness of the people. If the Government should shut down —well, Government shall not shut down. It would be unthinkable.

THE ATLANTIC CITY MEETING

IT is a far cry from St. Paul to New Orleans to San Francisco to Atlantic City, but in successive years the American Dental Association has held its annual meeting in these widely separated sections of the country, and each meeting has been conspicuously successful not only from the standpoint of attendance but from the standpoint of marking the advancement in the scientific progress of the profession; all of which shows that interest in dentistry is not determined by geographical limitations, and indicates a nation-wide interest in dental matters that is an earnest of the determination of the profession to extend the benefits of dental service to all quarters.

The Seventy-Ninth Annual Meeting of the American Dental Association recently held in Atlantic City, N. J., marks another conspicuous forward step in the progress of dentistry that must have been a source of much satisfaction to all who took part in this unusual meeting.

An attendance of over eleven thousand was well provided for by the spacious halls of the Municipal Auditorium. The large ballroom in which the general meetings were held accommodated one of the largest dental audiences the writer has ever seen, that of the Second General Session on Tuesday evening.

All of the eight Section meetings were fully provided for in ample halls with acoustic properties well adapted to their needs. The Section meetings were all well attended, and it was the first time in the past few years that we have seen the Section on Oral Surgery, Exodontia and Anesthesia provided with a meeting place sufficiently large to accommodate the audiences that have been attracted to these meetings. The attendance at the meetings of the Section on Operative Dentistry was quite unusual, which we interpret as indicating a long-needed revival of interest in a phase of dentistry that has been much neglected for the past few years, during which

time we have apparently been more concerned in removing teeth than in restoring them. The revival of interest in the operative phase of dentistry is positive indication of the appreciation generally of the desirability of attaining the health ideal expressed in the President's theme of "Preventive Dentistry in the Interests of Health." Removal of teeth which cannot be safely restored is quite necessary in the fight to eliminate and control oral focal infection, but restoration and prevention are even more essential in the ultimate attainment of mouth health.

The Partial and Full Denture Sections attracted almost as much attention as usual, and we believe it will be some years before our efforts toward prevention will in any degree diminish the wide need for denture restorative measures.

Interest in the associated group meetings seemed more intense this year than has been the case for many years. The National Society of Denture Prosthetists was in constant session for almost the entire week preceding the American Dental Association meeting, expressing an intensity of interest in their problems that has come to be characteristic of this group. The American Academy of Restorative Dentistry had equally interesting and important sessions, as also did the Editors Association, the fraternities, the honorary organizations, the hygienists and the dental assistants.

The activities of one associated group, the American College of Dentists, were particularly conspicuous at this meeting in the culmination of a profession-wide expression of appreciation of the services which Dr. William J. Gies has rendered to dentistry over a period of some twenty-five years. The Testimonial Dinner to Dr. Gies by the American College of Dentists was a tribute such as few men have ever received in dental circles. Some eleven hundred admirers of Dr. Gies joined with the American College of Dentists and practically all the national dental bodies in paying a well-deserved tribute to one who has unselfishly and generously contributed of his energy, time and substance to the promotion of the advancement of the highest ideals of dental health service over a period in which dentistry has achieved its most notable educational accomplishments.

An incidental feature of the meeting, and one that should arouse

the interest of every member of the American Dental Association, was the appointment of a Committee whose duty it shall be to formulate appropriate ways and means of celebrating, in 1940, the Centenary of the organization of the dental profession. In a short one hundred years, we have developed from what was practically a trade into a full grown profession, with a status of full recognition in professional circles. And it is this notable achievement that it is proposed to memorialize on the one hundredth anniversary of the establishment of the first dental society, the first dental school and the first dental journal.

A feature of the recent meeting that was a most impressive one, as well as a distinct contribution to the scientific development of dentistry, was the Scientific Exhibit, which was conspicuously noteworthy under the able sponsorship of Dr. George B. Winter, our immediate Past President. Dr. Winter deserves and received most favorable commendation of his efforts to make the scientific exhibit an outstanding feature of the Atlantic City meeting.

The Clinics, amply accommodated, held on Thursday afternoon and Friday, were the most elaborate ever held at any national meeting, and were representative of every section of the country and every phase of the practice of dentistry.

The House of Delegates, under the able leadership of President Miner, dispatched its usual duties in a most business-like manner, and terminated its activities in the selection of Dr. Marcus L. Ward, distinguished former dean of the Dental School of the University of Michigan, as President Elect, an honor well deserved and generously bestowed. The Vice-Presidents for 1938 are Dr. John S. Owens, Camden, N. J., Dr. T. A. Hardgrove, Fond du Lac, Wis., and Dr. R. D. Cummins, St. Petersburg, Fla. The place of meeting for next year is St. Louis, Mo.

We must, in closing, pay our compliments to the wonderfully capable manner in which the Committee on Local Arrangements, under the able direction of Dr. John S. Owens as Chairman, performed its many duties.

The arrangements for the meeting were all that could be desired, and contributed in a large measure to one of the most successful meetings ever held by the American Dental Association.

L. P. A.

ASSOCIATION ACTIVITIES

ACTIVITIES OF THE RESEARCH COMMISSION AT THE NATIONAL BUREAU OF STANDARDS

THE cooperative research program on dental materials has been in active progress at the National Bureau of Standards since 1928.

Do you know that the Research Commission of the American Dental Association maintains a fellowship at the Bureau from funds appropriated by the House of Delegates? Each member of the American Dental Association contributes 26 cents a year toward this research work, *i.e.*, 26 cents out of the 400 cents, or 6½ cents of each $1 you pay to the American Dental Association goes for our work at the Bureau.

Recently, I asked an officer of our Association this question, and I wish to ask you the same question, "What criticism have you heard about the work which we are conducting at the National Bureau of Standards in cooperation with the Federal Government and what suggestions have you for its improvement?" He replied in effect that he had not heard any unfavorable criticisms, but that he did believe the fine work which we were doing should be disseminated more widely; that as he became better acquainted with our program, he was more and more impressed with it, but he was convinced that the dentist was not well enough acquainted with it to apply the results effectively. "Get your message to the dentist," he said, "the profession appreciates your work, but not enough, owing to lack of information concerning your program."

Therefore, it is my privilege tonight to explain to you the activities of the Research Commission and to show how effectively your collective 26 cents have been converted into a practical knowledge of dental materials. Today, dental problems are so complex and numerous that adequate research on them is not a one-man job. We use metals and their alloys, organic materials, such as waxes, impression compounds, rubbers and synthetic resins, and ceramic materials, such as gypsum, cements and porcelains. It is evident that many men with specialized technical training are needed to investigate scientifically this wide variety of materials used in dentistry.

It is, therefore, most fortunate that since 1928 the A.D.A., with Federal support, has been able to assume and maintain the fellowship for research on dental materials at the National Bureau of Standards. Here, at this Bureau, are specialists in practically every field of physics and chemistry. Where in all the world could one find a more suitable laboratory in which to conduct exact investigations on dental materials?

What is the nature of the agreement between the Research Commission and the National Bureau of Standards in conducting this work? How does the

(Read before the Annual Clinic Meeting of the Cleveland [Ohio] Dental Society, May 3, 1937.)

research associate plan function? Well, the Bureau permits the cooperating agency, in this case the Research Commission, to use its laboratories and instruments and to station its own research workers at the Bureau. The Research Commission pays the salaries of these men and allocates funds to purchase or otherwise procure the materials to be tested; which, together with some executive expenses, comprise our total expenditures. The Bureau has also assigned two men from its own personnel to work on the dental materials problem. In addition, we have the consulting advice of the entire Bureau staff. Let us not estimate the probable cost to the Association for duplicate service in the commercial testing world, but let us ask a few questions: How much would the Association have to pay for the laboratory and office space which they use at the Bureau, if they rented it outside? How much would it cost the Association to duplicate, or even to standardize and keep in adjustment, precision machines and equipment which we use at the Bureau? What would be the consultation fee for a corps of experts similar to the Bureau staff, whose advice we seek and obtain? Need I go any farther in explaining to you the great advantage of having the unlimited facilities for research offered by an institution of this kind?

Wilmer Souder, the principal physicist of the Bureau staff, is chief of the Dental Materials Research Laboratory at the Bureau. I wish to pause here and pay tribute where tribute is due: The A.D.A. is associated with the Bureau because of a personality and that personality is Dr. Souder. The Bureau itself, and later with part time aid from the Weinstein Fellowship, carried on this work for ten years (1918-1928) before the A.D.A. recognized its responsibility toward this physical research program. Some day, the profession will fully appreciate Dr. Souder's close attention to their problems. We also have another worker at the Bureau who has brought credit to our Fellowship, George C. Paffenbarger. His analytical and creative mind has assisted in the solving of many complex problems.

I have discussed, in a general way, our connection with the Bureau. I shall now give a résumé of some of our specific studies.

So far, the Commission has developed standards for the following materials: amalgams, inlay investments, impression compounds, inlay casting waxes, inlay casting golds, wrought gold wires, dental mercuries and cementing media (zinc oxyphosphate cements). Reports of work done on silicate cements and denture-base materials during the past year will soon be released. A revised list of casting golds which meet the Commission's specifications will be found in the May 1937 issue of THE JOURNAL.

Thus, the main object of our work at the Bureau is to make available to the profession standards for dental materials and technics most suited to their specific purposes. The profession had either to set up its own standards for materials or rely on the claims of manufacturers and, oftentimes, over-enthusiastic clinicians. Please do not misunderstand me: Clinical tests are absolutely necessary and are the only ultimate proof that a material is practical. The ideal system is a combination of laboratory and clinical tests, one supplementing the other. This is the basis of our program, the laboratory work at the Bureau and the clinical tests by our own committee of cooperating dentists.

To make the standards effective in your daily use, the Research Commission has evolved the following plan:

1. After a specification is adopted, the

Research Commission asks the manufacturer to guarantee his product to comply with it; *i.e.,* the manufacturer sends to the Research Commission a formal certificate guaranteeing compliance of his product with our standard.

2. The manufacturer must prove to the Research Commission that he has adequate testing facilities and personnel for the routine testing of his guaranteed products or make use of a laboratory that does have such facilities.

3. The Research Commission procures on the open market a representative retail sample of the material which the manufacturer has guaranteed. Our research associates at the National Bureau of Standards test this material to see whether it meets the A.D.A. specification; *i.e.,* to see whether the manufacturer's guarantee is valid. If the material has the guaranteed quality which the manufacturer claims it to have, we place it on the list. This list of certified products has been published from time to time in THE JOURNAL, and in the future will be published quarterly. Read in the February 1937 issue of THE JOURNAL the annual report of the Research Commission. Then refer to the May issue and read the new list of casting golds. Compare these two lists. This will convince you that it is imperative to use the latest published list in making your purchases. What better method have you of obtaining a satisfactory material?

I wish to point out that we have one research associate whose entire time is now devoted to rechecking these materials on the certified lists as well as testing materials which manufacturers wish to add to the list. We hope, in the near future, to add the services of another worker so that more frequent inspection tests can be made on these materials.

The Research Commission is not interested in the name of the material as such, nor in its price or its sales management. These details will automatically adjust themselves. The Commission is solely interested in the quality of the product. All of our specifications are formulated with one thought in mind—*quality*. The price will adjust itself in the circle of commercial competition. Price is not always a criterion of quality. Occasionally, in our tests at the Bureau, we have found that some of the higher priced materials were inferior in quality. In the first amalgam survey, we found that one amalgam alloy selling for $6 an ounce was next to the poorest in quality of all tested. Frequently, in rechecking materials, we discover products on the certified list in which the manufacturer has not maintained the specified quality. These materials are then removed from the list. At a later date, the manufacturer may recertify his material to the Commission. If, at this time, the material is found to comply with the specification, it will again be placed on the list. We have excellent cooperation from the manufacturers and your insistence on certified dental products will make this work even more effective. In other words, you, not we, have put the program over, and the more you use the list as your buying guide, the more cooperation and assistance we shall have from the manufacturers. Please remember this: the manufacturer does not pay the Research Commission a cent for the inclusion of his product on the list. There is no fee. Big or little, manufacturers are all treated alike. We, the profession, are bearing the expense of this testing program, which is beneficial to us as well as to our patients.

Mr. Beall, one of our research associates, will describe in detail this part of our program at the Atlantic City meeting of the A.D.A.

About one-third of the research asso-

ciate's time at the Bureau is spent on this testing program. The other two-thirds of the time is devoted to research and the formulation of specifications.

We are just about to complete a three-year study of the silicate cements and have now formulated a tentative specification for them. This study, as you all know, has long been needed. The data to be presented will further emphasize this need.

I shall take just one item of this long research and relate what our fellows at the Bureau have reported to me. Let us consider the opacity of silicate cements. How opaque are they? How opaque should they be? How opaque are human tooth structures? Do the cements differ much in opacity? How can the degree of opaqueness be determined? These are some of the problems that confronted us in this one item alone. Opacity measurements were made on an instrument which was so designed that opacity of small areas can be determined. This instrument, the Priest-Lange Reflectometer, was developed at the Bureau several years ago.

A specimen of zinc phosphate cement about 1 mm. thick is 100 per cent opaque; *i.e.,* no light is transmitted through it. Silicate cements of the same thickness are not completely opaque unless they contain zinc oxide in considerable quantities. One silicate cement was only about 20 per cent opaque or, if you wish, 80 per cent translucent. The most opaque silicate cement was about 65 per cent opaque. I am informed that an average value for the opacity of human enamel is about 40 per cent; of dentin, about 70 per cent.

For discussion with dental schools and manufacturers, we have set a tentative required standard for opacity of silicate cements; *i.e.,* the opacity of the cements should not be less than 35 per cent nor more than 55 per cent.

We have also made studies on the composition of both powders and liquids, including their arsenic content; on the consistency of mix; on the time of setting under different atmospheric conditions; on the crushing strength after storing in different solutions, such as distilled water, natural saliva and mineral oil; on the influence of temperature and humidity of the mixing environment on the physical properties of the cements; on staining with dyes; on the effects of prematurely exposing the silicate cement to water or saliva; on the temperature rise on setting; on the acidity and alkalinity of the powders, liquids and mixed cements; on solubility and disintegration; on the variance of physical properties among batches and colors of the same cement; on the dimensional change on setting; on the effect of humidity of the air on the physical properties of the cement.

A complete report of this work will be given by Drs. Paffenbarger, Schoonover, and Souder in the Research Section of the A.D.A. at the meeting in Atlantic City. Part of your 26 cents was expended on the silicate cement research.

We have also been studying the denture base materials, the *sine qua non* of prosthesis. If we had had a specification for these materials, the exploitation of the last few years would have been impossible.

I have been talking about 26 cents tonight. How much has it cost you to experiment with these synthetic substitutes for rubber? The answer you give to this question will be the classic example of the enormous waste of time, energy and money of both the dentist and patient which can be expended on uncorrelated clinical experimentation. As I survey the existing chaos in this field, I am more than ever convinced that, in a great number of instances wherein the clinical tests

are in the hands of innumerable persons, with no central control nor correlation, the securing of accurate or even reliable service statistics is difficult, if not impossible.

A study of variations among batches of vinyl resins and among the batches of phenol-formaldehyde resins shows them to be vastly different. If one uses the same technic for each batch, and of course one should, greatly different results can be expected. If different technics are used, greater variations will be found. We are studying these phases of the problem at this time.

Data have been obtained on the following properties: tensile strength, elongation or set, impact strength, flexural fatigue, water absorption, softening point, warping, color life, heat transfer or thermal conductivity, shelf life, composition and solubility.

Vinyl resins are a mixture of vinyl acetate and vinyl chloride molecules. The size of the molecule and the proportional amounts of each size have a relation to the physical properties of the resin. By fractional solubility determinations, the relative amount of each size group can be ascertained. If one batch of vinyl resin has a high proportion of large molecules, *e.g.*, those having a long chain structure, it will, in general, have better physical properties than a batch having large proportions of relatively small molecules, *i.e.*, those having a short chain length. However, the long chain structure is not very plastic at permissible forming temperatures and the result is a denture with high strain, which may warp or crack. If the forming or pressing temperature is raised, the resin discolors. The short chain structure is somewhat the reverse. Different proportions of short and long chain groups will have different softening temperatures. One pressing technic will not suffice for all combinations which were found. Perhaps this helps to explain some of the many failures in service of these materials.

I have attempted to give you a little insight into our program of research at the National Bureau of Standards. I wished to show that our paramount interest is in seeing that you get better dental materials, better therapeutic agents, which will enable you to render a better health service—the goal of our profession.

P. C. LOWERY, *Chairman,*
The Lowery Building,
Detroit, Mich.

LIST OF CERTIFIED PRODUCTS, 1936-1937

A revised list of dental materials which have been certified to the Research Commission by the respective manufacturers as complying with American Dental Association specifications is given below. This list will be revised as new certifications are received or as materials are checked for compliance with specifications.

CERTIFIED AMALGAM ALLOYS A.D.A. SPECIFICATION NO. 1[1]

Samples of all amalgam alloys, inlay casting investments, impression compounds, inlay casting waxes, inlay casting gold alloys, dental mercury and zinc

1. PAFFENBARGER, G. C., and SWEENEY, W. T.: "Specifications and Certifications for Dental Materials." J.A.D.A., 21:658, April 1934.

phosphate cements certified to the Research Commission of the American Dental Association by the various manufacturers as listed herein were purchased in the open market by the Research Commission and tested by the A.D.A. Research Associates at the National Bureau of Standards. As of July 1, 1937, the following list of alloys was found to comply with American Dental Association Specifications. Certified materials which did not comply are omitted from this list.

FOURTH SURVEY OF ALLOYS
(May 4, 1935)

Alloy	Manufacturer or Distributor
Accurate Metalloy (filings)	The L. D. Caulk Co.
Ackerman (filings)	Ackerman Dental Mfg. Co.
Argentum (shavings)	Hammond Dental Mfg. Co.
Argentum (filings "A" cut)	Hammond Dental Mfg. Co.
Argentum (filings, medium cut)	Hammond Dental Mfg. Co.
Argentum (filings, fine cut)	Hammond Dental Mfg. Co.
Aristaloy	Baker & Co., Inc.
Banner (filings)	Goldsmith Bros. S. & R. Co.
Blue Diamond (filings)	Reliance Dental Mfg. Co.
Brewster Medium (shavings)	E. R. S. Brewster
Brewster Quick (filings)	E. R. S. Brewster
Brewster Quick (shavings)	E. R. S. Brewster
Capeako (filings)	Precious Metals Refining Works
Certified	Lee S. Smith & Sons Mfg. Co.
Coe	Coe Laboratories, Inc.
Diamond Edge	Young-Baker & Co.
Dee (filings)	Thomas J. Dee & Co.
Excel	Daniels Dental Alloy Co.
Fellowship (filings) (medium setting)	The Dental Protective Supply Co.
Minimax (filings) (shavings) 172 173	The Minimax Co.
173 177	The Minimax Co.
174 178	The Minimax Co.
177 180	The Minimax Co.
178 161	The Minimax Co.
180	The Minimax Co.
181	The Minimax Co.
183	The Minimax Co.
161	The Minimax Co.
Minimax White Gold & Platinum	The Minimax Co.
Mission No. 5	San Diego Smelting & Refining Co.
Mission No. 5 "A" cut	San Diego Smelting & Refining Co.
Mission No. 6	San Diego Smelting & Refining Co.
Modeloy (Quick Setting) (filings)	Crescent Dental Mfg. Co.
Ney-Aloy	The J. M. Ney Co.
Ney-Aloy No. 125	The J. M. Ney Co.
Odontographic "Improved" (filings)	Odontographic Mfg. Co.
Preferred D	Precious Metals Refining Works
Preferred C	Precious Metals Refining Works
Royal-Special First Setting	Garhart Dental Specialty Co.
Silverloy (filings & shavings)	Crescent Dental Mfg. Co.
Speyer	Speyer Smelting & Refining Co.
S-C Medium (filings)	Stratford-Cookson Co.
S-C Quick (filings)	Stratford-Cookson Co.

True Dentalloy (filings)	The S. S. White Dental Mfg. Co.
True Dentalloy (cut A)	
Twentieth Century (filings)	The L. D. Caulk Co.
White Beauty	Lang Dental Mfg. Co.

Certified Inlay Casting Investments A.D.A. Specification No. 2[2]

Second Survey of Investments
(June 24, 1935)

Investment	Manufacturer or Distributor
Coecal Inlay	Coe Laboratories, Inc.
Coecal Universal	
Kerr Cristobalite-Inlay	Detroit Dental Mfg. Co.
Kerr No. 3	
Ransom and Randolph Gray	The Ransom & Randolph Co.
Ransom and Randolph Green	
Ransom and Randolph X-45	
S. S. White Inlay No. 20	The S. S. White Dental Mfg. Co.
Security Improved Inlay	The Cleveland Dental Mfg. Co.

Certified Impression Compounds A.D.A. Specification No. 3[3]

Third Survey of Impression Compounds
(August 1, 1935)

Compound	Manufacturer or Distributor
Brewster	E. R. S. Brewster
Certified	Lee S. Smith & Son Mfg. Co.
Dresch	The Ransom and Randolph Co.
Kerr Black	Detroit Dental Mfg. Co.
Kerr No. 3	
Kerr Perfection	
Kerr White	
Moyer	The J. Bird Moyer Co.
S. S. White—Black—Tray	The S. S. White Dental Mfg. Co.

Certified Inlay Casting Waxes A.D.A. Specification No. 4[4]

Third Survey of Inlay Waxes
(August 1, 1935)

Wax	Manufacturer or Distributor
Brewster	E. R. S. Brewster
Caulk-Blue	L. D. Caulk Company
Kerr-Blue—Hard	Detroit Dental Mfg. Co.
Maves	The Heidbrink Co.
Peck's Blue	A. E. Peck Mfg. Co.
Security	The Cleveland Dental Mfg. Co.

2. Taylor, N. O.; Paffenbarger, G. C., and Sweeney, W. T.: "Dental Inlay Casting Investments: Physical Properties and Specification." J.A.D.A., 17:2266, December 1930.

3. Taylor, N. O.; Sweeney, W. T., and Paffenbarger, G. C.: "Specification for Dental Impression Compounds." J.A.D.A., 18:53, January 1931.

4. Taylor, N. O.; Paffenbarger, G. C., and Sweeney, W. T.: "Specification for Inlay Casting Wax." J.A.D.A., 18:40, January 1931.

Certified Inlay Casting Gold Alloys A.D.A. Specification No. 5[5]

Second Survey of Inlay Casting Gold Alloys

(February 15, 1937)

Alloy	Type*	Manufacturer or Distributor
Aderer-A-Soft	A	Julius Aderer, Inc.
Aderer-B-Medium	B	
Aderer-C-Hard	C	
Chilcast No. 1	A	Vernon-Benshoff Co.
Chilcast No. 1-A	B	
Chilcast No. 2	C	
Chilcast No. 2-A	B and C	
Deetwo Light	A	Thomas J. Dee & Co.
Deetwo	B	
Dressel	C	Julius Aderer, Inc.
Goldsmith Inlay No. 1	A	Goldsmith Bros. S. & R. Co.
Goldsmith Inlay No. 2-Medium	B	
Goldsmith Inlay No. 3-Hard	C	
Jelenko Alboro Inlay	C	J. F. Jelenko & Co., Inc.
Jelenko Durocast	C	
Jelenko Modulay	B	
Jelenko Platin-Cast	B	
Jelenko Special Inlay	A	
Ney-Oro A	A	The J. M. Ney Co.
Ney-Oro A-1	B	
Ney-Oro A-10	B	
Ney-Oro B	C	
Ney-Oro B-2	C	
Spyco Hard	B	Spyco Smelting and Refining Co.
Spyco Soft	A	
Spyco No. 6	C	
S. S. White No. 1	B	The S. S. White Dental Mfg. Co.
S. S. White No. 2	A	
S. S. White No. 13	C	
S. S. White No. 31 Metalba	B	
S. S. White No. 820	B and C	
S. S. White No. 940	A	
Stern No. 2847	C	I. Stern and Co.
Stern No. 3290	B	
Stern No. 3337	C	
Stern No. 3375	A	
Stern No. 3441	C	
Stern No. 3465	B and C	
Tinker No. 1	B	Spyco Smelting and Refining Co.
Tinker No. 1H	C	
Tinker No. 2	C	
Tinker Inlay	B	

*Relative hardness: A, soft; B, medium; C, hard.

5. Taylor, N. O.; Paffenbarger, G. C., and Sweeney, W. T.: "Inlay Casting Golds: Physical Properties and Specifications." J.A.D.A., 19:36, January 1932.

Certified Dental Mercuries A.D.A. Specification No. 6[6]

Second Survey of Mercury
(February 2, 1937)

Mercury	Manufacturer or Distributor
Argentum	Hammond Dental Mfg. Co.
Chemically Pure	The S. S. White Dental Mfg. Co.
Dee	Thomas J. Dee & Co.
Dental	Goldsmith Bros. S. & R. Co.
Mercury Laboratories	Mercury Laboratories, Inc.
Minimax	The Minimax Co.
Mission	San Diego Smelting & Refining Co.
Mynol	Mynol Chemical Co.
Ney's C. P.	The J. M. Ney Co.
Odontographic	Odontographic Mfg. Co.
Positively Pure	Garhart Dental Specialty Co.
R. P. C.	Research Products Corporation
Spectropure	Baker & Co., Inc.
Twentieth Century	The L. D. Caulk Co.

Certified Wrought Gold Wire Alloys A.D.A. Specification No. 7[7]

Alloy	Manufacturer or Distributor
Deepep-Hard	Thomas J. Dee & Co.
High Fusing Clasp	Goldsmith Bros. S. & R. Co.
Jelenko No. 3 Wire	J. F. Jelenko & Co., Inc.
Jelenko Super Wire	J. F. Jelenko & Co., Inc.
Medium Clasp	Goldsmith Bros. S. & R. Co.
Ney-Oro Elastic No. 2	The J. M. Ney Co.
Ney-Oro Elastic No. 4	The J. M. Ney Co.
Neydium 9	The J. M. Ney Co.
Regular Clasp	Goldsmith Bros. S. & R. Co.
Spyco No. 3	Spyco Smelting and Refining Co.
Spyco No. 4	Spyco Smelting and Refining Co.
Stern No. 2657	I. Stern and Co., Inc.

Certified Zinc Phosphate Cements A.D.A. Specification No. 8[8]

Second Survey of Zinc Phosphate Cements
(February 1, 1936)

Cement	Manufacturer or Distributor
Ames Z-M	The W. V-B. Ames Co.
Caulk, Crown & Bridge	The L. D. Caulk Co.
Caulk, Petroid Improved	The L. D. Caulk Co.
Caulk, Tenacin	The L. D. Caulk Co.
Fleck	The J. R. Stanley Chemical Co.
Lang	Lang Dental Mfg. Co.
Smith	Lee S. Smith & Son Mfg. Co.
S. S. White, Zinc	The S. S. White Dental Mfg. Co.

6. Isaacs, Aaron: "Mercury for Dental Amalgams." J.A.D.A., 19:54, January 1932.

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BUREAU OF PUBLIC RELATIONS

THE CHILD AS A PATIENT

By CLIFFORD SWEET, M.D., Oakland, Calif.

NEARLY all dentists and physicians treat children; therefore all, except those few who exclude from their practice all children, even those who are members of the best families, should learn as much as possible about children. This knowledge should not be limited to the ailment for which the child is to be treated, but should include the entire life of the child as a growing, intelligent, sentient human being with a personality which deserves as much respect and more consideration than that of an adult.

All human beings are controlled by their emotions and their reason. Those of adult size are not truly adults until a long process of experience and education has enabled them to develop reasonable control of their emotions. The child must grow up physically, mentally and emotionally. He differs from the adult only in that he lacks experience and has not yet developed his mental powers, nor that unselfishness and that respect for the opinions of others with which no person is endowed, but which all must learn who would live successfully and happily.

While children have had, generally, a limited experience, they may have had a considerable association with those of us who practice the healing art and the memories of their contact with us may have been both necessarily and unnecessarily unpleasant as well as of such nature that they may seem to have been especially designed to arouse the evil that is in us, patient as well as doctor. Of necessity, some of our ministrations to our patients are painful, or, at best, unpleasant. Every means in our power should be used to reduce pain to a minimum for all patients, but more especially for children. The child's undeveloped reason cannot comprehend the benefits which he will obtain from treatment, while his fully developed emotional nature will long be conditioned by his response to pain. However, anesthetics are not the only means of reducing the unfavorable results of painful experiences, nor is a lack of them the sole basis for the child's dread and distrust of the dentist or the physician.

Parents must be taught that it is "an offense in the eyes of the Lord" to use the doctor as a bogey man. All bogey men are cheats and liars and make but a poor screen behind which to hide the lack of an intelligent system of child training. A frightened child can hardly be expected to cooperate with his medical attendant, and his frantic resistance may make difficult or impossible early, and therefore effective, aid in the time of emergency. Any adult who says to a child, "Now dear, it won't hurt," when he knows that pain is to be inflicted, is a fool and a liar. He is a fool—so evidently that I am not in the least afraid of "hell-fire" for naming him one—and I don't want him for a brother anyhow, and he at once forfeits the child's confidence. He is a liar be-

cause he has told a wilful untruth, and Angelo Patri well says, "Any kind of parent will do except a liar," and I beg leave to extend Mr. Patri's remark to doctors.

Frank, genuine sympathy, expressed by action and word, does much to soften or remove resentment toward one who must inflict pain. It is true that many children will "yell" all of the time they are being worked on, even though no pain is being suffered, thereby obtaining emotional escape and a certain sense of security; since, on the basis of past experience, yelling has been a potent means of escape from disagreeable situations. I once had as a patient a small boy whom I had to transfuse many times. He was a most exemplary and cooperative patient, but shrieked throughout each operation. One day his mother shouted at him, "Don't yell like that," and he replied at the top of his vocal powers, "It doesn't hurt so much when I yell like that." Against this type of crying or yelling, there is only one defense, and that is to pay no attention to it, going steadily ahead to finish one's task in the shortest possible effective time. This is the only method that will reduce vocal protest to a minimum, since, once realizing that it is worthless, either as a means of defense or of "getting the doctor's goat," the intelligent child abandons it.

Crying out in response to pain is normal and should not be classed as a behavior problem based upon original sin. Therefore, I condemn without reservation the doctor who responds to it with such epithets as "bad child," or who loses his temper and so far forgets the compassion for all humanity which our training teaches us that he becomes even rougher and more ruthless. We would do well to remember my friend Dr. Mead's remark about a cystoscope, "It has two ends, one comfortable and the other uncomfortable."

I can testify after years of experience with them that when children are treated fairly and truthfully told that pain must be inflicted on them, they are the most satisfactory patients, often putting to shame by their quiet fortitude their supposedly more hardy elders. Therefore, I cannot be patient with adults who make light of a child's outcry and say, "Oh, he's just a kid; let him yell," or "He is just pretending there's a pain in order to get out of something." I cannot recall without a surge of emotion the little boy with a badly broken arm whom I saw on a mountain trail and who, when told that I must straighten the arm in order to immobilize it and that it would hurt, said, "All right, doctor," and when the ordeal was over, murmured through ashen lips, "Thank you, doctor." Again my emotions rise when I think of a fine boy who came to me on the fourth day of manifest tetanus, too late for effective treatment, because his constant complaints had been regarded as an attempt to "pull a fast one and get out of going to school." Children are not malingers. In the first place, life is too interesting and exciting to run the risk of missing any of its thrills unless pain or discomfort is so intense that it cannot be disregarded. Furthermore, children are essentially honest, learning only gradually from the adult world about them of the advantages that seem to arise out of the dark and devious ways of deception.

I have spoken of sympathy, but I would not have you think that I condone in any way the maudlin imitation of the genuine article which prompts inadequate parents to postpone needed treatment because the child is afraid of the doctor, or a like manifestation on the part of the doctor who attempts to sugar coat his own lack of "intestinal fortitude" with many "sweethearts" and "dearies," while doing insufficient or slipshod service for the child.

Every child responds naturally to a frank, friendly, courteous greeting which indicates that the doctor recognizes in him what he has long known himself to be, a normal, important, fellow human being. I wonder if there is one among us here today who would not be grievously affronted and hurt if, being in a company of three or more persons, he should be omitted from introductions and friendly salutations. At least, he would not be in a mood to yield gracefully to any request his ungracious companions might make.

When I enter the room to examine a new patient, I am introduced to the child by the nurse in the same manner as to the adults, and I respond as cordially to one as to the other no matter what the child's behavior may be. If his behavior indicates fright, I can understand when I remember the low state of my own courage when some dentist has said, "Now open wide, please." If he is sullen, I must not condemn him until I know whether his previous treatment has been such that he may not be blameless. If he is pugnacious, I must remind myself that he has been brought to me whether or not he wanted to come; while adult patients, except certain husbands, have at least some part in choosing their doctor and the time at which they will visit him. Also, having won nearly, if not all, the pitched battles with adults in which he has previously cared to use his full powers, he naturally doesn't hesitate to join me in battle since he doesn't yet know that I can and will use all the force necessary to subdue him, while teaching him to realize that a smile may accompany force as well as service. When he finally yields the unequal struggle, I must not gloat and can offer him some salve for his vanquished spirit by saying "thank you" and going on with my work as though no conflict had taken place. "Thank you" and "if you please" are valuable means of approach to the inner citadel of any one's heart. If their effect on a child is not apparent at once, perhaps he is surprised that an adult is so considerate; also, a child's reaction time between suggestion or command and execution is longer than is that of adults. Frequently when I ask a child to do something which I am certain he intends to do willingly as soon as he can comprehend and carry out my wishes, he is stung into a refractory state by the querulous, commanding voice of his parent saying, "Why don't you do what the doctor asks? *Do it immediately.*" All children can appear to be completely absorbed with their own affairs, and yet be fully aware of every word and act of those about them. Whether this ability, which enables the child to maintain an expressionless countenance while his mind is a perfect recording apparatus storing up material for future use, is a part of the traditional wisdom of babes and sucklings or whether it is one of the defenses which he must build up against the too frequent invasions of his personality by adult companions, I am not certain. Perhaps it has something in it of both—subject peoples have always outwitted their rulers. A little girl lay upon an examining table shrieking at the top of her voice. I said to her mother "Has she a good appetite?" and the mother replied "I don't know; we make her eat whether she wants to or not." I then said, "That is unnecessary." During this conversation, there was no interruption, or reduction of the volume, of the child's yelling. Yet that evening, having been car sick on the way home, when her nurse tried to make her eat her supper she said in exactly the manner in which I had spoken, "That is unnecessary."

There is only one way to use force with kindness and that is to use it effectively

without scolding, threats or any display of emotion. I take time to instruct the mother or nurse as to how to hold the child so that he can be rendered helpless. I can usually win the mother's cooperation by explaining to her that each time she frees her child, he will have to suffer the discomfort and ignominy of being thrown again and that worse still he may be hurt severely or even injured if he is allowed to grab my hands while I am using an instrument in his mouth, nose, ear or eye. In the course of time I have learned effective holds and, during the depression, my vagrant thoughts strayed to wrestling or even sheep shearing as side lines.

I have written at some length on the psychologic attributes of children because no one can manage them successfully who does not understand the fundamental workings of the human mind. More briefly, I shall outline two fundamental physical differences between the child and the adult.

Growth sharply differentiates the child from those human beings who are no longer growing. Growth, especially during the periods when it is rapid, makes many demands. Nutrition must be maintained in a nearly perfect state if nutritional anemia, rickets, tetany and rampant dental caries are to be avoided. Tremendous amounts of energy are used in the process of growth, the replacement of which cannot be accomplished without an abundance of rest as well as of food. During and after rapid growth periods, the nervous system is apparently under strain and needs a period free from unnecessary conflict in which to consolidate its gains. Young, growing or recently grown tissue is fatigued easily and is often permanently damaged by overexertion. Competitive athletics among young children is a crime against the future of a generation. One need only mention the diseases, such as measles, diphtheria, scarlet fever, poliomyelitis, acute rheumatic fever, osteomyelitis, bone and gland tuberculosis and dental caries, which are suffered almost exclusively in childhood to realize that young tissues lack the immunologic defense which is present in later life. Whether this immunity is acquired specifically as a result of once having had the disease or is a natural by-product of maturity and age is as yet an unsettled question.

The second difference between the child and the adult is purely physical only in its end-results, but has in its beginning and development much that is environmental. Since environment can be directly affected by our efforts, it is within its limits that the most gratifying results of education and training are developed. I refer to such functions of every-day life as seeing, walking, standing and chewing. It seems to me that educators (and are not all of us who work with children educators?) assume too readily that every child will learn to see, stand, walk and chew naturally. True, he will do so after a fashion, but may fall far short of the perfection which he might attain were his natural powers developed properly. If children are taught to stand and walk according to the highest standards of our present knowledge of body mechanics, much of the misery that arises from backaches and so-called flat feet will be prevented, and tremendous amounts of precious energy will be saved for constructive work and the joy of living.

All children who have normal eyes can see after the first few weeks of life, but the ability to fuse the separate images of either eye into a single image having three dimensions has to be learned as does walking, and does not appear until about the eighteenth month. If the visual acuity of the eyes is approximately equal, no difficulty arises, but if only one forms a

perfect image, the less than perfect image is disregarded, with rapid loss of visual acuity in the unused eye. There is no way to prevent this loss of vision unless the difficulty is discovered early and glasses are properly fitted. Myopia (near sight) is progressive unless relieved early by means of glasses. No child's eyes can be refracted accurately and glasses prescribed accordingly except with the use of atropine in sufficient amount to produce temporary paralysis of the muscles of accommodation. Optometrists, since they cannot legally use atropine, cannot accurately refract the eyes of children, and dentists and physicians should so inform their patients.

The addition of solid foods to his diet is an event in the life of an infant. This change demands that he learn a new lesson. Some learn it easily, while others have difficulty. The latter group must be given very finely divided food and have it made coarser gradually in order to prevent choking and the development of strong psychologic aversion to all foods other than liquids or purees. All successful programs of education must be begun at a level sufficiently low to make accomplishment easy and then must reach higher levels at a rate determined by the ability of the individual. If progress is continuous, one must not demand speed. Meat is the stumbling block in the chewing education of most children because nearly all of them like it so well that they overfill the mouth and form an unchewed mass that even an adult could swallow only with difficulty. When this difficulty presents itself, meat should be given one piece at a time and a second piece given only after the first is chewed and swallowed. Mechanical imperfection of the jaws makes chewing difficult, demanding that difficulties in the form of coarser and tougher food be increased slowly. On the other hand, since growth takes place in the direction of use, increasing function near the upper limits of successful accomplishment must be insisted on.

Children can be cared for properly only by the combined efforts of dentists and physicians. The dentist must demand of the physician that he give the child complete examinations and careful guidance. The physician must demand of the dentist that he carry out all the prophylactic measures known to dental science, and that when caries is present, it be treated with permanent contoured fillings. Temporary fillings have no place in dentistry, and the loss of dental structures because of unnecessary neglect or poor workmanship is deplorable.

Working together, we can raise the standards of dentistry and medicine for children and be rewarded with a satisfaction which transcends all material rewards. In our hands lies the skill and in our hearts may there be lighted a white flame of enthusiasm, energy and understanding which will make clear the way to that time in the life of man when every child may fully develop his native gifts; and the greatest of these is health, for on it all the others come finally to depend.

2940 Summit Street.

THE RELATION OF DENTAL INFECTION TO SYSTEMIC DISEASES*

Announcer: We are in the office of Dr. L——, dentist and oral surgeon, where we meet our old friend, Jack Bradford, who has been sent to Dr. L—— by his family physician, Dr. J——.

Here is Jack in the dental chair and Dr. L—— has just entered the room. Let's listen in.

Dr.: Good morning, Mr. Bradford. Are you having trouble with your teeth?

Mr. Bradford: Not exactly, doctor, but Dr. J—— sent me over here for an examination. It's my stomach that bothers me most. I don't think there is anything wrong with my teeth.

Dr.: Well, maybe there isn't, but let me look in your mouth.

Mr. Bradford: All right, doctor, but I know my teeth are in good condition. Dr. J—— *is* suspicious of this crowned tooth, however.

Dr.: Well, let me look. Mn . . . open wider . . . I see . . . I see. It seems to me, Mr. Bradford, that you ought to have *all* your teeth x-rayed.

Mr. Bradford: But doctor, why don't you x-ray just this tooth that Dr. J—— is worried about? Why do you want to x-ray all of my teeth, when Dr. J—— is only suspicious of that one tooth?

Dr.: Because all these other teeth are suspected until they are tested and examined. A tooth that looks healthy in the mouth may be badly diseased below the gum line; therefore, it is necessary to have an x-ray examination of all of the teeth to be sure that we are not overlooking any infected ones.

Mr. Bradford: Just the same, doctor, I've heard some funny things about this full-mouth x-ray examination. A friend of mine has a complete upper plate in his mouth, and his dentist told him to have all of his teeth x-rayed. So he took out his upper plate and had the place where he didn't have any teeth x-rayed. What do you know about that?

Dr.: That is not so funny as it seems. We have found from experience that one out of every three persons who have all their teeth out has one or more roots left in the jaw bone or tissues, and invariably these roots are infected.

Mr. Bradford: Do you mean to tell me that when a person is wearing false teeth he can still have infection in his gums?

Dr.: Yes, indeed. A person can have what we call residual infection. You see, when the teeth have been removed, parts of the tooth, pieces of fillings, loose spicules of bone or abscesses which fail to drain may be left in position and become covered up by the gum tissues. These breed infection, and they are just as dangerous as infected teeth. In fact, they are more dangerous, because you are not aware that they are present in your mouth and they can be revealed only by the x-rays. Even your family physician can't see them. That is why many oral surgeons today make a regular routine of taking an x-ray picture just after an extraction or oral operation. This post-operative x-ray picture affords an immediate check on all possible future trouble, without waiting for that trouble to develop. The likelihood of residual infection can be eliminated before the incision has healed.

Mr. Bradford: That's interesting, doctor; but to get back to why I came here:

*A type of radio talk, sponsored by the Medical Society of the District of Columbia, that is particularly interesting and has a very definite health education value.

Last week, I felt low—no pep, then pains in my stomach, and now—here I am in a *dentist's* office.

Dr.: Well, part of your trouble may be due to faulty chewing of your food, and resulting indigestion. Then again, it may be due to the presence of infected teeth which are discharging pus into your system. I expect that Dr. J—— sent you here so that I could tell him whether your teeth could be causing this run-down condition. In other words, your poor health may be an expression of a generalized infection which comes from your teeth.

Mr. Bradford: But if my teeth might be the cause of my general condition, why don't they tell me so by aching?

Dr.: An infected tooth doesn't always ache. It doesn't necessarily cause pain or swelling. As a matter of fact, most infections do not cause any discomfort at all until long after they start, because the patient's physical resistance is high enough to control the infection; but once the physical resistance or tone is lowered, the infection becomes more pronounced; particularly in a localized area, such as in the mouth.

Mr. Bradford: Just the same, I've heard some very funny things about having teeth out for general health. A friend of mine had arthritis and he had all his teeth removed, yet he still has his arthritis. How do you account for that?

Dr.: That's easy! There are many types of arthritis and, naturally, infected teeth do not cause all kinds. One type is caused by improper diet. This is known as a gouty arthritis. There are many other types which your physician would be glad to explain to you, but I dare say that if Dr. J——'s recommendation as to the removal of your friend's teeth was carried out, his physical condition was improved. Even though infected teeth may not be the sole cause of certain types of arthritis, their removal does benefit the patient by allowing the medicine which he takes for his arthritis to work more efficiently. In any case, your friend did not lose good teeth. Those teeth were proved to be bad before any dentist would extract them. Even though they did not perhaps cause his arthritis, they would have given him other trouble later on—perhaps even worse things than arthritis.

Mr. Bradford: Yes, I have heard that. But it's too general—what other trouble do bad teeth cause?

Dr.: Infection of the teeth can cause heart disease, kidney disease, neuritis, ulcerative colitis and many other diseases. In fact, the great majority of all chronic diseases of the body can be caused by, or influenced by, infection of the teeth.

Mr. Bradford: How can you be sure of that, doctor?

Dr.: By experience; by what past records show. For instance, many people who have been suffering from a certain type of heart disease have always improved when infected teeth, tonsils or other foci of infection have been removed.

Mr. Bradford: What is meant by focal infection?

Dr.: Focal infection is a working theory that has become popular within the last twenty years, but it is not new in the practice of medicine. All of the great physicians of earlier times noted that infected teeth were associated with certain chronic debilitating diseases, and they felt sure that the infected teeth were in some way the cause of these other conditions. Although they didn't give this theory any special name, they recorded their opinions and observations in their writings. They noted that pus starting from bad teeth always traveled to other parts of the system. About twenty years ago, the medical profession began to refer to this as focal infection; that is, an infection in one part of the body causing infection or

disease in another part of the body.

Mr. Bradford: Then, if this tooth of mine is abscessed and if you remove it, will that eliminate the infection from my mouth and improve my general health?

Dr.: If this crown tooth is infected and we remove it, we will also have to remove the pus sacks along with the tooth. These we call granulomas, but you perhaps know them best as abscesses. You see, it isn't just a tooth we remove, but the pus, which does the damage.

Mr. Bradford: Well, I'd like to ask about this business of extracting teeth. Some of my friends have a tooth pulled in the afternoon and eat their dinner, and go to the theater, and have no trouble. Others have the same tooth and same kind of pain, but they have to keep coming in for treatments for two weeks or more after a tooth is pulled. Now, I'd like to have the first kind of an extraction, with no discomfort or extra visits. Can I be sure of this?

Dr.: No one can guarantee anything about what will happen after an extraction. All teeth are not the same, just as all people are not the same. In some cases, after the teeth are removed, the sockets heal without any postoperative difficulty. Others do not heal readily, owing, in most instances, to the poor physical tone of the patient. We have a condition commonly known as "dry socket," in which the blood clot that is supposed to form in the socket does not form, or, if it does, lasts only a day or two, and then breaks down, leaving the opening of the tooth socket accessible to the fluids of the mouth, as well as to the various irritating kinds of food which the patient eats. This is painful, and daily dressings are required to control the pain until enough protective tissue has formed to take care of the exposed tissue nerves normally.

Mr. Bradford: I hope that doesn't happen to me! But will all infection be removed from my mouth if I have my bad teeth out?

Dr.: If all of your infected teeth are removed, it is perfectly possible to keep your mouth in a normal, healthy condition, free of all infection. But you must visit your dentist at least twice a year, and remember to brush your teeth several times a day, after each meal, of course, and also when you first get up in the morning, and just before you go to bed. A great deal of harm can be done by wrong brushing methods, and it is desirable to receive proper instruction in the brushing of your teeth. Most people have the habit of brushing the teeth in a circular or sidewise motion. This was considered good some ten years ago, but now it is considered best to brush your teeth in one direction only; that is, from the gum margin out toward the edge of the tooth. And it would be even better to include some of the gum in this brushing. The gums harden and become strong only by use and exercise, and the toothbrush properly stimulates circulation and restores the tissues, which are most necessary to the teeth.

Mr. Bradford: Suppose the x-ray picture shows that more than one tooth has to come out: is it better to have a lot of teeth removed all at once or one tooth at a time?

Dr.: Your question cannot be answered in the abstract. It is a very important question, but there are so many factors to be considered that everything depends on the individual case. There are two schools of thought regarding the number of teeth that can be extracted at one time and both are right in certain cases. As I have said, everything depends on the patient. His physical condition is always the deciding factor. Some sick people cannot stand to have more than one tooth out at a time. Others, who have a need-

less dread of the ordeal, should have them all out at once, if the general health is good. I know of many cases in which all thirty-two teeth have been removed at one time and with the best possible results to the patient. The oral surgeon, in cooperation with the patient's physician, should determine at the time just how many teeth should be removed. You see, we are dealing with human cases, not just with teeth. There is, for instance, a wide variation of opinion regarding the extraction of diseased teeth from an expectant mother.

Mr. Bradford: Is it safe to remove teeth while a woman is pregnant?

Dr.: Of course it is. In fact, in the early stages of pregnancy, it is an accepted routine of the medical profession today to get the mouth into a healthy condition. If there are any infected teeth, they are removed and all teeth needing fillings are restored to a normal effectiveness. This helps the mother and the baby, and tends to prevent unnecessary discomfort in the later stages of pregnancy, when a mother's energy should be conserved, instead of being dissipated by unnecessary worry or pain. This brings up the question of the fear that exists in the minds of some people regarding the extraction of teeth. It is a strange thing to find that in this day and age there are people who still dread to go to the dentist and have a tooth removed.

Mr. Bradford: Well, after all, isn't the extraction of a tooth always a dreadful experience?

Dr.: Certainly not. With our modern methods and with the intelligent care which the dentist is able to give, there should never be any pain while a tooth is being extracted, because the dentist is able to select the one special type of anesthetic that will best serve this individual case. At times, it is advisable to use a local anesthetic, such as novocaine, and sometimes it is advisable to use nitrous oxide and oxygen, which is a general anesthetic. You know nitrous oxide and oxygen as gas. But the selection of the anesthetic should be left to the dentist, who can best make this choice in the interests of his patient, instead of the patient insisting on a certain type which might not be the best in the particular case.

Mr. Bradford: Well, I have heard doctors say many things about the relationship of the teeth to general health, but I didn't know just how this relationship existed. I thought that whenever the physician was in doubt about a general illness or low vitality, he was just trying to "pass the buck" to the dentist.

Dr.: No, there has been no "buck passing." In reality, the physician has known for a long time the relationship of infected teeth to other diseases, and he has endeavored to cooperate with the dentist in order that the patient might at least have good dental health. That is most important, since a person cannot have an unhealthy mouth and have a healthy body. All branches of the medical profession, you see, are working together to give you a sound body. Just mere local patch-work is not enough. The human body functions as one complicated unit, not several hundred detached parts. You must be healthy all along the line, and that's why Dr. J—— sent you here for my cooperation.

Mr. Bradford: Thank you, doctor, and I'll gladly cooperate with you in this part of the maintenance of my health.

Dental hygiene exhibit, Vienna.

VIENNA, AUSTRIA, ORAL HYGIENE EXHIBIT

On the previous page are three views of the oral hygiene exhibit recently presented in Vienna. They were furnished by Balint Orban, who some years ago was in charge of the histologic laboratories of the Chicago College of Dental Surgery and who is now in dental practice in Vienna.

The large revolving unit of the exhibit was patterned by Dr. Orban from the "Answer Your Own Dental Questions" chart, prepared by the Bureau of Public Relations of the American Dental Association. In addition to the large chart, the Vienna Dental Society exhibited twenty-four large posters, each illustrating one of the answers found on the central chart.

GEORGIA'S NEW DIVISION OF DENTAL HEALTH EDUCATION

The State Department of Public Health of Georgia takes pleasure in announcing the addition to its staff of J. G. Williams as dental consultant. This is an honorary appointment. Dr. Williams has for a number of years served unofficially as dental advisor. With the appointment of Dr. Williams, a division of dental health education has been established in the department of health. Prior to this time, the dental program was a department in the division of child hygiene. Miss Annie Taylor will continue as educational director and Miss Mary Harley as associate director.

A. D. A. RADIO BROADCASTS OVER COLUMBIA NORTHWEST AND SOUTHWEST CHAINS

Through the cooperation of the Columbia Broadcasting System, the American Dental Association's weekly radio programs are being made available to the following stations at 12:15 p.m., Central Standard Time.

*KNOW—Austin, Texas
*KRLD—Dallas, Texas
*KTRH—Houston, Texas
KLRA—Little Rock, Ark.
*KOMA—Oklahoma City, Okla.
*KTSA—San Antonio, Texas
*KWKH—Shreveport, La.
*KTUL—Tulsa, Okla.
*WACO—Waco, Texas
KGKO—Wichita Falls, Texas
*KFH—Wichita, Kans.
WIBW—Topeka, Kans.
WOC—Davenport, Iowa
WCCO—Minneapolis, Minn.
WNAX—Yankton, S. D.
KSCJ—Sioux City, Iowa
KFAB—Omaha, Nebr.
WTAQ—Green Bay, Wis.
WISN—Milwaukee, Wis.
WMBD—Peoria, Ill.
*KRNT—Des Moines, Iowa.
WKBB—Dubuque, Iowa

*These stations are now using our programs.

Subjects and Dates for the Coming Month

August 3: The Shammar Bedouin Diet and Dentistry
August 10: Curious Tales of Teeth
August 17: The Dentist Turns Detective
August 24: A Missing Tooth Traps a Thief
August 31: A Denture Saves a Detective's Life

DENTAL ECONOMICS

THE DENTAL ASPECT OF PUBLIC HEALTH

By LEON R. KRAMER,* D.D.S., Topeka, Kans.

NEVER has there been such a simultaneous awakening and universal activity in the dental profession as in the last two years. The cause of this unusual stir is the general recognition of the fact that, up to the present time, dentistry has been grossly negligent in conveying to the public its message of health. The dental profession has also come to realize that this phase of dentistry can be most effectively carried out by placing a full-time dentist on the state board of health.

The question may arise at this point "Why should this method of attack be preferable to placing responsibility directly on the dental profession?" The answer is: The state boards of health are departments created by the states. Their prime functions are to collect data and statistics on morbidity and mortality and to fulfil the health educational requirements of the state. Winslow defines public health as "the art and science of preventing disease, prolonging life and promoting physical and mental efficiency through organized community effort." This definition gives an exact picture of what we may hope to accomplish.

The state board of health, being authorized by the state to print, broadcast and otherwise spread the gospel of health, is in an ideal position to promote community health programs and to ask for the cooperation of dentists, physicians, nurses and teachers in this activity. Experience has taught us that this method of approach eliminates a type of criticism that is so often made against programs promoted by local medical or dental societies.

A dentist with specialized training in public health work can do much to enlarge the scope of activities of the dental profession. There is a vast field in public health work that awaits exploration. As dentistry becomes more closely associated with public health problems, it will more firmly entrench itself in the minds of the public as a profession worthy of the highest respect and consideration.

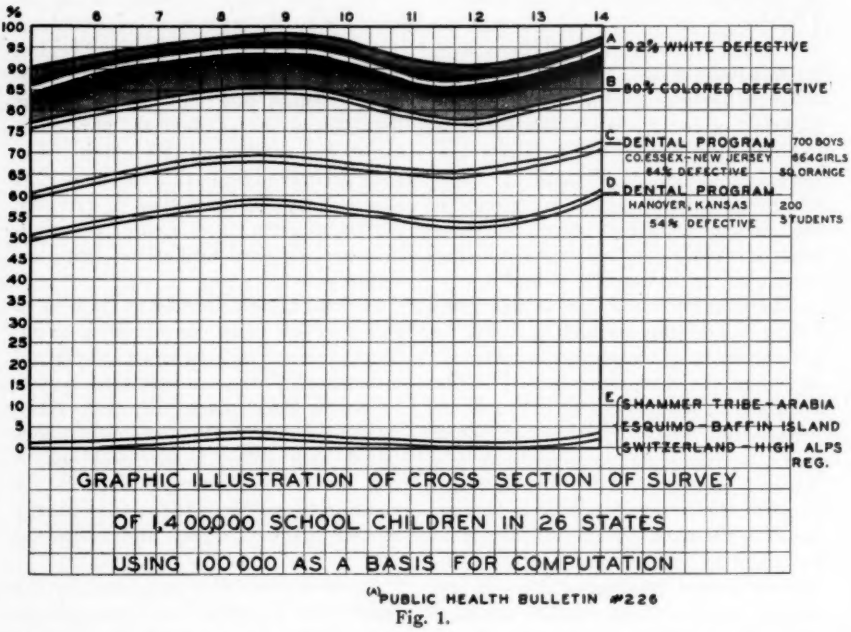
A community plan promoted by the department of public health also affords each dentist an opportunity to associate himself with a program in which he is considered an authority. This affords an entrée to civic and community interests that heretofore has been denied many men of the profession.

Authoritative articles and mats for state-wide use of component societies in the promotion of health education can also be supplied by the dental division of the state department of health.

*President of the Kansas State Dental Association and Director of the Division of Dental Hygiene, Kansas State Board of Health.

(Read in a final seminar postgraduate course for public health officers, Vanderbilt University, November 1936, and at a meeting of the Oklahoma State Dental Association, Tulsa, April 4, 1937.)

In order to cast some light on the field of public health, especially as it affects dentistry, we shall consider the various problems and show the dental relationship to their solution. Public health opens up opportunities for a service that has up to now been given little or no thought or consideration. When the facts are generally known, we shall all come to realize that dentistry has a greater task ahead of


%
6 7 8 9 10 11 12 13 14
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
A 92% WHITE DEFECTIVE
B 80% COLORED DEFECTIVE
C DENTAL PROGRAM 700 BOYS
ESSEX-NEW JERSEY 864 GIRLS
84% DEFECTIVE 50 ORANGE
D DENTAL PROGRAM
HANOVER, KANSAS 200
54% DEFECTIVE STUDENTS
E SHAMMER TRIBE-ARABIA
ESQUIMO-BAFFIN ISLAND
SWITZERLAND-HIGH ALPS
REG.
GRAPHIC ILLUSTRATION OF CROSS SECTION OF SURVEY
OF 1,400,000 SCHOOL CHILDREN IN 26 STATES
USING 100 000 AS A BASIS FOR COMPUTATION

(A) PUBLIC HEALTH BULLETIN #226

Fig. 1.

food and protection. Cavities, gum flaps, abscesses and pyorrhea pockets afford the finest culture media for cocci, bacilli, spirochetes and other organisms to develop their most virulent human cultured strains.

As regards mouth sanitation, surely if it is important to use sanitary measures to clean up the external environment, it is decidedly important to clean up the

it than any other single department in the public health service.

Following are some of the major problems as they confront us today:

The unclean mouth, with cavities and diseased and abscessed gums, may rightfully be called the incubator and brooder of practically all types of disease germs. The mouth supplies everything necessary for the propagation of germs, either aerobic or anaerobic; *e.g.*, moisture, warmth, pus-exuding abscesses and gums, putrefactive, decaying foods and débris found in the mouths of hundreds of thousands of children and adults. A diseased mouth is the cesspool of the human system, comparing with excreta and sewage in the count of pathogenic organisms. Detailed studies reveal that a diseased mouth plays an important part in the unfortunate sequelae of the communicable diseases of childhood, if not in actual disease itself.

According to the findings of the major clinics, 70 per cent of the foci of infection above the base of the neck are found in the oral cavity. It seems almost superfluous to mention it. As certain premature deaths, heart disease and some types of arthritis are charged to invasion of the blood stream by pathogenic organisms during childhood, abscessed teeth having their roots in the very marrow of the bone certainly are important factors in these conditions.

In cases of malnutrition and anemia, it would be well to examine the child's mouth to make sure it is not the presence of sore teeth that causes him to avoid certain necessary foods. Often, soreness of the teeth is the principal factor in the avoidance of hard and sweet foods.

In the treatment of tuberculosis and other depleting diseases, the elimination of infection in the mouth relieves the resistive property of the blood of much work and it can then be utilized in combating the major disease. A clean, healthy mouth is necessary to the cure of tuberculosis.

In syphilis, most of the metallic poisoning of the mouth, which is not only harmful to the supporting structure of the teeth, but also often slows up treatment, can be eliminated if the mouth is given a thorough prophylactic treatment by the dentist. This treatment, followed by frequent application of moistened soda between the teeth, will do much to prevent mouth disorders during treatment. Wherever and whenever infection is found in the mouth, it should be eliminated before treatment of the various diseases in order to prevent pathogenic organisms from entering the system via this route.

The mouth is one of the important contact areas in the spread of disease. Kiss-

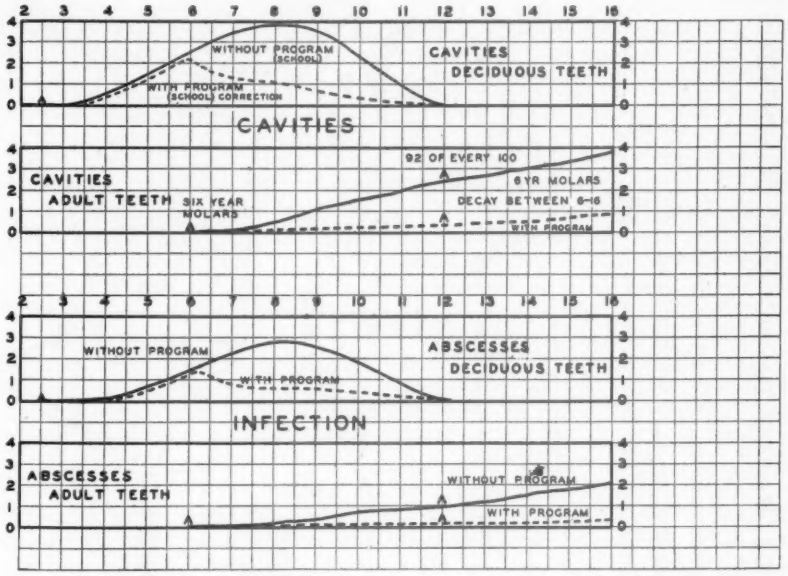


Fig. 2.

MAP DEPICTING PROBLEM OF DENTAL HEALTH EDUCATIONAL AND CLINICAL NEEDS BASED ON NORMAL CONDITIONS

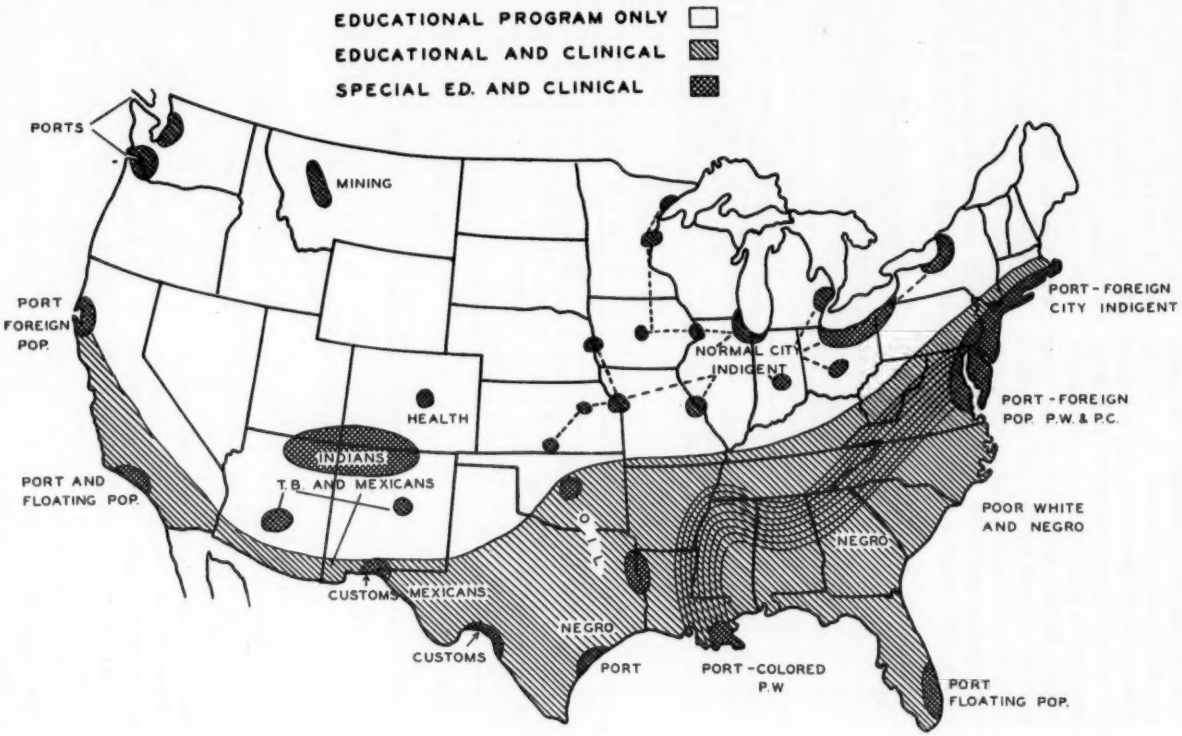


Fig. 3.

ing, chewing of food by nurse or mother for the baby, promiscuous use of chewing gum, vaporous breath, expectoration and contact by means of glasses, lead pencils, dishes, spoons, knives, forks and other things commonly placed in the mouth, are worthy of consideration in epidemiology.

The observant dentist can be made a valuable ally in case finding. Especially is this true in syphilis (mucus patch), diabetes (serumnal exudation around the teeth), cancer and deficiency and industrial diseases.

DISEASES OF THE MOUTH

There are diseases and food and water poisoning, both epidemic and endemic, that select the mouth for a base of activities. The more important ones are as follows:

Vincent's Infection.—This disease, if it is not diagnosed and given timely treatment, and if instruction is not given in the use of cups, towels and similar objects, may involve whole families and become epidemic, causing great economic loss and destruction of the supporting structures of the teeth.

Mottled Enamel.—This condition is endemic in many localities. Although fluorine poisoning is not measured by a death rate chart, it causes the teeth to become so unsightly that it affects the economic status of the person so afflicted. It is estimated that it costs, on the average, $1,000 to restore such a mouth with the latest approved type of dental service. There has been no practical method devised to combat fluorine-poisoned water except a change of water supply or dilution to reduce the content to less than 1 part per million.

Dental Caries.—If there were a disease that attacked the fingernails causing decay, abscesses and loss of health in nine out of every ten children and adults in the nation, every medical college, clinic research laboratory and foundation would be busy in their efforts to solve the problem. Nine out of ten children suffer with the endemic disease of their teeth which causes the very things mentioned above. Each child has only ten fingernails; whereas, between the age of one and eighteen, he produces fifty-two teeth. Furthermore, pus and germs in the mouth are mixed with every morsel of food the child swallows. This is a condition that has existed in our nation for years and is getting worse each year. It is a sad state of affairs that only a few leading minds in the dental and medical professions have recognized this condition as a challenge to our knowledge and to our civilization. So many times it is a man outside the medical and dental professions who has been sufficiently emboldened by a knowledge of the truth to set up standards for combating ignorance in the knowledge of physical education and care of the child. If the men outside the professions see the dire need of an active, vitalized, aggressive fight against these appalling conditions, surely the men in the allied medical professions should awaken to their obligations.

Figure 1 is a cross-section of the data collected by examining the mouths of 1,400,000 children in twenty-six states. This survey shows that dental caries is no respecter of economic status; rich and poor are attacked alike. Dental caries is just as prevalent in one state as in another. That the disease is endemic explains the fact that, even though the child or adult receives dental care, new cavities develop during the year, and therefore the percentage of children needing dental care each year will always stay at a high average per hundred. Colored children show an average mouth condition about 12 to 15 per cent better than that of white children.

Fig. 3.

Only in specialized, intensive educational and correctional programs can this percentage be reduced as shown, one at 64 per cent, the other at 54 per cent. The lower line on the chart shows how much better other types of civilization have adjusted themselves to their environment with regard to tooth formation and resistance to decay than our civilization has done.

Figure 2 is a graphic illustration of the progressive stages of disease and decay in both deciduous and adult teeth in the life of the child to the age of sixteen, based on the composite of the average child's mouth. The dotted line illustrates the improvement brought about by an intensive program, embracing the teaching of fundamentals in diet, oral hygiene and frequent inspection and early correction of abnormalities, as demonstrated in a school in Kansas. It also shows the necessity of preschool care of the dental needs of the child. About seven and one half of the deciduous teeth of the average child will decay between the ages of two and one-half and twelve, of which three and seven-tenths will form abscesses. Abscessed teeth are particularly formidable between the ages of three and one-half and seven, owing to the length of the roots and their relation to the germs of the permanent teeth and the copious blood supply. Of the child's first permanent molars (adult teeth), three and eight-tenths will decay between the ages of six and sixteen; if not repaired, two will form abscesses, which become potential foci of infection to the child's system if not removed.

Premature extraction and abnormal retention of deciduous teeth cause about 80 per cent of malocclusion. Mouth breathing, thumb sucking, faulty habits and heredity account for the other 20 per cent. This survey indicates that between 15 and 20 per cent are affected by facial and mouth deformities caused by malocclusion. They are facial cripples.

The deductions made from these data, unless adequate dental care is provided, are as follows:

There are approximately 35,000,000 school children in the United States. During their grade and early high school years, they will have had: 5,100,000 cases of apparent malocclusion; 225,000,000 cavities in deciduous teeth; 111,000,000 abscesses in deciduous teeth; 114,000,000 decayed first permanent molars (adult teeth), and 60,000,000 abscessed first permanent molars.

Without including disease of the gums, accidents, cases of mottled enamel, deficiency diseases and many other abnormalities, the foregoing figures represent a total of 515,000,000 cases of decay, disease and abnormal conditions. Should this, in the face of civilization's challenge, mar the record not only of the dental profession but also of all the allied medical professions? Is not the solution of this problem worthy of the interest of various foundations for special study?

As dental care of oral abnormalities which involves discomfort and some pain, is more than 90 per cent operative, the greatest hazard to the successful treatment is the element of fear. This necessarily demands of the dentist working with children the study of child psychology, the psychology of fear, the maladjustments in otherwise normal minds, and controlled conditioning of the child's mind. The principles of mental hygiene are important factors in outlining a county, state or national program.

PROGRAM

The statistics given in this and other surveys have shown that the problem of oral disease is not confined to the indigent nor to any state or locality. It is a plague which attacks the entire popula-

tion. These findings also substantiate earlier deductions from a philosophic and economic viewpoint, that education is the foundation upon which the structure of the division of dental hygiene should be built. From personal observation in traveling through thirty-six states in the last three years, combined with authoritative information received from states not visited, a map (Fig. 3) has been drawn to illustrate the constant special problems in the various states in the union under normal conditions. In many states, a certain amount of clinical work will have to be done as long as the problem exists or is unsolved, if adequate dental treatment is to be rendered. This condition, therefore, requires that the educational program be sufficiently flexible to allow for adjustment to meet these special problems.

It was with this background of assembled deductions that the Kansas plan was built. An effort was made to create a program that would conform to the ideals of the educator, the dentist, the health officer, the nurse, the psychologist and the statistician and, probably most important, promote the desire for, and emphasize the necessity of, a healthy mouth in the minds of the child and its parents. Deviations probably will occur, but a program built on ideals is worth the efforts spent in attainment.

The Kansas plan was based on seventeen years of experimentation in the Kansas State Dental Association and the analysis of the success of certain counties that have continued their program unremittingly over this period of time.

The object of presenting this paper in four phases was to show:

1. Why and how the dental division of the department of health can render its most effective service to the dental profession and to the public by basing its program primarily on education.
2. The service the dental division can render in assisting in the work of other divisions of the health department.
3. The tremendous problem facing the dental profession and the division of dental hygiene in the state departments of health.
4. The application of tried and tested principles in formulating a program that reflects the ideals of the various professions involved.

Dental caries in children is a problem of such magnitude that the dental profession will need the assistance not only of the medical profession, but also of nurses, teachers, parents—in fact, of all groups and individuals that have the good of the child at heart.

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COUNCIL ON DENTAL THERAPEUTICS

ACCEPTED DENTAL REMEDIES

The following articles have been accepted as conforming to the rules of the Council on Dental Therapeutics of the American Dental Association. The Council wishes dentists to understand that the admission of an article does not imply a recommendation. A copy of the rules that govern the Council in the consideration of articles will be sent on request.

SAMUEL M. GORDON, *Secretary.*

LOCAL ANESTHETICS*

Solution of Epinephrine Hydrochloride 1:1000-U.S.P. (See A.D.R. 1935, p. 108.)

Epinephrine Hydrochloride Solution 1:1000-Abbott: A brand of Solution of Epinephrine Hydrochloride 1:1000, U.S.P., containing 0.2 per cent sodium bisulfite as a preservative.

Manufactured by Abbott Laboratories, North Chicago, Ill. No U. S. patent or trademark.

Epinephrine Hydrochloride Solution 1:1000-Abbott in 1 ounce Bottles.

Epinephrine Hydrochloride Solution 1:1000-Abbott in 1 cc. Ampoules.

Procaine-Abbott: A brand of procaine hydrochloride, U.S.P. (See A.D.R. 1935, p. 43.)

Procaine-Epinephrine Solution-Abbott: Each cubic centimeter contains procaine hydrochloride 0.02 gm. (one-third grain), epinephrine 0.00004 gm. (one-sixteen-hundredth grain), sodium bisulfite, 0.001 gm., and potassium sulfate and chemically pure water to make an isotonic solution.

Procaine-Epinephrine Solution-Abbott, 1 cc. Ampoules.

Procaine-Epinephrine Solution-Abbott, 100 cc. Bottles.

Procaine Hydrochloride Solution 2%-Abbott: Each cubic centimeter contains procaine hydrochloride 0.02 gm. (one-third grain), sodium chloride and chemically pure water to make an isotonic solution.

Ampoules Procaine Hydrochloride Solution 2%-Abbott, 1 cc.

Ampoules Procaine Hydrochloride Solution 2%-Abbott, 5 cc.

Procaine Hydrochloride Solution 2%-Abbott, 100 Cc. Bottles: Each cubic centimeter contains procaine hydrochloride 0.02 gm., sodium bisulfite 0.001 gm., sodium chloride and chemically pure water to make an isotonic solution.

ANNUAL MEETING OF THE COUNCIL ON DENTAL THERAPEUTICS

It is an established principle of the Council on Dental Therapeutics to advise the members of the dental profession and the public of its decisions as soon as circumstances permit. In accordance with the established principle, the following items discussed during the last meeting of the Council, which may be of interest to both dentists and manufacturers, are authorized for publication.

SAMUEL M. GORDON, *Secretary.*

*A.D.R. 1935, p. 34.

The Council on Dental Therapeutics of the American Dental Association held its eighth annual meeting at the Central Office, 212 East Superior St., Chicago, Ill., Sunday and Monday, April 18 and 19, 1937. The following members were in attendance: J. Howard Brown, Ph.D., associate professor of bacteriology, Johns Hopkins University, Baltimore, Md.; Paul J. Hanzlik, M.D., vice chairman of the Council, professor of pharmacology, Stanford University School of Medicine, San Francisco, Calif.; Thomas J. Hill, D.D.S., professor of clinical oral pathology and therapeutics, Western Reserve University School of Dentistry, Cleveland, Ohio; Milan A. Logan, Ph.D., instructor in biologic chemistry, Harvard Medical School, Boston, Mass.; Arno B. Luckhardt, M.D., Ph.D., Sc.D., LL.D., professor of physiology, University of Chicago, Chicago, Ill.; Harry Lyons, D.D.S., profesor of periodontia and oral pathology, Medical College of Virginia, School of Dentistry, Richmond, Va.; John A. Marshall, Ph.D., D.D.S., professor of dental pathology and biochemistry, University of California, College of Dentistry, San Francisco, Calif.; Victor C. Myers, Ph.D., Sc.D., professor of biochemistry, Western Reserve University, schools of medicine and dentistry, Cleveland, Ohio; U. Garfield Rickert, A.M., D.D.S., professor of diagnosis, dental therapeutics and radiology, University of Michigan, College of Dentistry, Ann Arbor, Mich.; Harold S. Smith, D.D.S., chairman of the Council, 180 North Michigan Ave., Chicago, Ill.; Samuel M. Gordon, Ph.D., secretary of the Council, Chief, A.D.A. Bureau of Chemistry, Chicago, Ill.; C. N. Johnson, D.D.S., LL.D., Editor, THE JOURNAL, Chicago, Ill., ex-officio member; Harry B. Pinney, D.D.S., Secretary, American Dental Association, Chicago, Ill., ex-officio member.

Thomas L. Grisamore, Trustee of the American Dental Association, and L. Pierce Anthony, Associate Editor of THE JOURNAL of the American Dental Association, were present on invitation.

Harold S. Smith was nominated to the board of trustees for reelection as chairman of the Council. Paul J. Hanzlik was reelected vice chairman of the Council.

STATISTICAL SUMMARY OF THE COUNCIL'S WORK

The Council was apprised of the numerical status of the products before it as of March 25, 1937. The tabulation is given below for the interest of the members of the profession:

Products announced as accepted in THE JOURNAL	279
Products announced as not acceptable in THE JOURNAL (including Notices of Judgment)	291
Products reaccepted (Since April, 1935)	68
Products omitted from A.D.R.	40
Products not acceptable, but reports not yet published	143
Provisional acceptance and acceptance recommended	43
Acceptance not recommended, but still under consideration	19
Awaiting more evidence from proprietor for final disposition	8
Products acceptable, announcement delayed	2
Awaiting report of referee	5
Consideration postponed	24
Exempted list	35
Official drugs in A.D.R.	193
Products examined in the Bureau of Chemistry—findings not published	60
Total	1210
Minus items 3 and 4	108
Net total	1102
Products discussed in answer to inquiries, etc., not including the foregoing, approximately	950
Total products brought to the attention of the Council	2052

Such statistical information, while indicative of the trend of the Council's work, does not represent the actual scope of the work being done by the Council or the work carried on in the Council's office, single handed, by the Secretary of the Council, who also is chief of the A.D.A. Bureau of Chemistry. Indeed, it is difficult to express educational and spiritual progress in cold figures.

It is important to know that, as a result of the Council's work, desirable changes are taking place in that a more intelligent outlook than previously is had on drugs used by dentists. Fewer worthless proprietaries for treatment of pyorrhea and tartar removal, etc., are placed on the market, or succeed in making much headway, largely as a result of early inquiry by the Council. There are desirable changes in instruction in materia medica, therapeutics and pharmacology in dental school courses; an increasing use of only Council-accepted products or official products in dental infirmaries and in private offices, and the cooperation of responsible manufacturers in furnishing useful official drugs at reasonable cost.

The foregoing tabulation does not take into account the large correspondence between individual members of the profession and of the laity on products within the scope of the Council. The profession is becoming more interested in the work of the Council, as is evidenced by the inquiries received from dentists. The public is more and more being made aware of the Council's work on dentifrices by radio programs and published material from reliable sources. Inquiries from lay sources on "safe" dentifrices continue to be a source of contact between the public and the Association. Consequently, many inquiries for lists of acceptable dentifrices are answered daily, and information based on the Council's findings is sent to these lay correspondents, particularly to young people of school and college age.

It is also pleasing to note that more state dental societies are being guided by the Council's views and are consequently assisting their members by not accepting for their commercial exhibits products which have not been made acceptable to the Council.

ACCEPTED DENTAL REMEDIES

The Council has again noted with appreciation the desire of the dental profession, and particularly of the teachers, for the new edition of Accepted Dental Remedies, brought up to date. The Council has sorely regretted that the governing bodies did not make available a small appropriation for underwriting publication of the new edition, as requested at the San Francisco meeting. After discussion, the Council voted to inform the Board of Trustees that it was ready to proceed with the revision of Accepted Dental Remedies by bringing it up to date, as soon as the necessary funds were made available. In view of the failure to follow through last July, the Council cannot undertake this revision without assurance that funds will be available before starting on it. (Funds have now been provided. It is anticipated that Accepted Dental Remedies 1937 will be available in September.)

The Council noted with appreciation the efforts of schools and state dental societies in importuning the Board of Trustees to make this available. If funds are provided immediately, it is hoped to have the volume ready for distribution in September, 1937.

Because of this unfortunate circumstance, consideration of many technical problems that revolve around Accepted Dental Remedies was postponed.

CONSIDERATION OF MECHANICAL APPLIANCES

While the Council, for the moment, has declined to consider mechanical appliances for acceptance, it has, as occasion demanded, made reports on the use of certain physical

therapy apparatus that has been promoted to dentists with unwarranted claims. Because of the many requests coming to the Central Office of the Association, the Council agreed to undertake a critical examination of these outfits with the collaboration of careful and critical clinicians in the field of periodontoclasia.

DENTIFRICES

Medicinal Agents in Tooth Paste.—The Council has consistently emphasized the limitations of a dentifrice in that it is nothing more than an aid to the toothbrush in cleaning the surfaces of the teeth. It has consistently emphasized that a tooth paste should not be medicated even though it has recognized that several tooth pastes on the market have been medicated on the basis of ideas discarded in dentistry. Medication should be in the hands of a dentist or a physician. If a dentist desires to apply a medicament by means of a powder or a paste, there are methods and pharmaceutic preparations available for this; but, for daily use, a tooth paste should be free from medication.

Some of the more widely advertised dentifrices on the market appear to be medicated. Ipana Tooth Paste avowedly contains betanaphthol, the active constituent of ziratol. ("Ziratol, Not Accepted for A.D.R.," J.A.D.A., 21:2223, December 1934.) A brief summary of the actions of this drug may be helpful. Betanaphthol has been used as an anthelmintic. It is known to be very irritating to the skin and mucous membranes and in excessive amounts produces epigastric and diffuse abdominal pain, nausea, vomiting, diarrhea, muscle spasm, depression of the respiratory center and, at times, hemolysis, convulsions, respiratory and cardiac paralysis and coma. Consequently, its use as an anthelmintic is being abandoned. These conditions refer to systemic action. What may happen from ingestion of small amounts over long periods of time or from repeated rubbing of phenol on healthy or unhealthy gums is worthy of serious consideration by dentists who may be urged to suggest a tooth paste containing betanaphthol.

It is to be noted that while a product containing alphanaphthol was listed as accceptable in the early history of the Council, it no longer appears on the list of accepted dentifrices, for the reasons mentioned above.

Calox Tooth Powder contains sodium perborate, which has been incriminated as a source of chemical burns of the mouth. (J.A.D.A., 22:1761-1764, October 1935.)

S. T. 37 Tooth Paste contains hexylresorcinol, which has been incriminated as a cause of dermatitis venenata. (Templeton, N. J., and Lunsford, C. J.: "Cheilitis and Stomatitis from S. T. 37 (Hexylresorcinol Tooth Paste)." Arch. Dermat. & Syph., 25:439-443, March 1932.)

Potassium chlorate, which appears in Pebeco, on continued ingestion may give rise to serious damage to the viscera. ("Potassium Chlorate in Dentifrices." Editorial, *J.A.M.A.*, 108:1343, April 17, 1937.)

Orris root was found in Dr. Lyon's Tooth Powder and other less widely advertised brands, despite the fact that many people are allergically sensitive to it.

The Council desires to emphasize again the fact that there are available on the accepted list of the Council dentifrices whose compositions have been submitted to the scrutiny of the Council and whose advertising is relatively honest. They may be used with apparent safety. Their virtue lies partly in the fact that they are not frankly medicated.

Use of Lead Tubes for Tooth Paste.—Several common metals are used for making tubes for marketing tooth pastes and other pharmaceutic articles. These are generally lead, lead coated with shellac, lead coated with tin, tin and aluminum. Attempts have been made from time to time, to promote the use of plastic tubes.

The use of lead in containers for marketing products which are used daily over a

number of years may not be desirable in view of the possible danger of chronic lead poisoning, a condition which demands the serious attention of public health officials.

In view of these circumstances, the Council will henceforth not admit to its list of accepted dentifrices any tooth paste which is marketed in a lead-containing tube.

Bacteria in Dentifrices.—Certain dentifrice manufacturers, of which the Kolynos Company is the most prominent, persist in promoting their dentifrices with antiseptic claims, despite the fact that the Council has not been able to accept such claims. The Federal Trade Commission has, on several occasions, objected to such claims.

The following abstract of interest in this connection appeared in *Zeitschrift für Stomatologie* (33:895, July 26, 1925).

Inasmuch, as in coming to a decision with regard to the value of mouth and tooth preparations, the question of harmlessness is vital; and inasmuch as with unsuitable compositions harm can be caused to the mucous membranes and the teeth, therefore, incidentally to other investigations, the bacterial contents of current toothpastes were tested.

For the experiment, eleven different preparations (original packages in tubes bought in the open market) were used of which two of the pastes, according to the claim of the manufacturer, were described as disinfecting or germicidal. Only two preparations were sterile, while the rest, including those described as disinfecting or antiseptic, were found to contain large quantities of bacteria. The following bacteria were found: *Bacterium pneumoniae, Bacillus mucosus-capsulatis (B. friedlander), Staphylococcus pyogenus-aureus, Staphylococcus albus,* many sarcinae, *Bacillus subtilis, Bacillus butyricus, Bacillus putrescenti,* and other organisms found around the uvula, soft palate and pillars of the tonsils.

As for judging the results that nine of the eleven investigated tooth pastes contain pathogenic besides infectious types of bacteria, we must observe that most of the bacteria that exist in the pastes are also found in the mouth. Therefore, in a concrete case of infection with such bacteria, it must remain undecided whether the infection may be ascribed to the tooth paste. On the contrary, we must, for hygienic considerations, take the point of view that the dentifrice needs no bactericidal qualities, but at all events should be sterile.

It is unfortunate that the names of the tooth pastes examined were not given. However, the information indicates the care with which the problem must be viewed.

This was discussed by the member of the Council in charge of this class of products. It was believed that no action should be taken at this time. At least, it was noted, one would not relish using a preparation of the sort described. The preparation might be viewed as a dirty product rather than one containing pathogenic organisms. There remains the possibility that if such organisms are present, other organisms which might do harm might also be present. Could hemolytic streptococci remain alive in common tooth paste mixtures? This might be undesirable.

The Council therefore reiterates its position on accepting dentifrices containing preservatives or antiseptic agents which may be considered harmless under conditions of use. It cannot accept claims for mouth antisepsis because of the presence of such agents.

DENTURE ADHERENT POWDERS

In the report of the 1936 annual meeting of the Council, it was pointed out that the Council decided no longer to admit adherent powders for dentures to A.D.R. (J.A.D.A., 23:1554, August 1936.) The Council suggested that dentists acquaint themselves with the full composition of such products as they may suggest for their patients' use.

Since the last meeting of the Council, a number of inquiries have been received from physicians concerning the composition of these products and their possible rôle in the onset of certain diseases, such as tuberculosis and other infections of the chest, anemia and drowsiness. The Council pointed out in Accepted Dental Remedies that these

products are largely composed of various gums, karaya being the most common, since it is the least expensive. Sometimes, acacia and tragacanth are used. Others contain, in addition to the gums, borax or other compounds.

The Council was concerned with the letters from physicians relating some untoward incidents that were supposedly related to the use of these compounds. While the evidence tending to condemn the daily use of these gums is not clear cut, it should suggest caution concerning their indiscriminate use. The continued ingestion of borax, for example, which is commonly mixed with these gums, could not be considered beneficial and might be harmful. The Council was of the opinion that if it were still considering these products for admission to its official list, it would not, in all likelihood, accept some of them, because of the presence of potentially harmful substances, such as borax.

The Council notes that the claims made for these products in dental journals as a rule are less objectionable than they were before the formation of the Council, and this could not be considered a basis of objection. It would appear desirable to eliminate all but gum and flavoring from these products, unless clear-cut evidence is available that the addition of such substances is harmless over long periods and there is valid justification for their use.

DISINFECTION OF INSTRUMENTS BY CHEMICAL MEANS

The Council has noted the widespread use of solutions, presumably for the so-called "cold sterilization" of dental instruments. None of these products have been admitted to Accepted Dental Remedies, to date. Accepted Dental Remedies, 1935, suggests the use of a formaldehyde solution in alcohol and other nonaqueous solvents, to which alkaline substances, as rust-inhibitors, are added. In suggesting this use, the Council attempts to differentiate clearly between a disinfectant and a sterilizing action. These terms are further defined below.

The difficulties of procuring agents which will sterilize with the same degree of safety as heat are appreciated by the Council. The circumstance that most dentists do not possess apparatus for sterilizing by heat under pressure, and the common feeling that sharp instruments were injured by such treatment, are appreciated.

These, and similar considerations, which are now under investigation in the referee's laboratory, induced the Council to agree to accept such preparations provided they are marketed only as disinfectants and not as sterilizing mediums. Aside from consideration of name, composition and other factors which are encompassed in the rules of the Council, particular attention will be given to the evidence available for their efficiency as disinfecting agents.

The Council has noted that some of these products are said to kill sporulating organisms, but, on further inquiry, it is learned that these were used only in the vegetative form. Preliminary experiments made by the referee indicate that they do not kill spores.

"STERILIZATION OF CAVITIES"

In the course of a discussion on the use of mercurials and other agents for disinfecting instruments, the application of these to so-called "cavity sterilization" was discussed. Because of the method of application and the time in which cavity "sterilizing agents" are used, it is doubtful that they are effective as sterilizing agents, despite the fact that this type of material and procedure are commonly used in operative dentistry. It appears desirable that there be introduced into the dental vocabulary a more appropriate term than "cavity sterilization" for the wiping of cavities after an operative procedure. A

term which readily suggests itself is "cavity wiping," somewhat analogous to the wiping of wounded areas in general surgery.

The Council goes on record as disapproving the use of the terms "sterile," "sterilizing" and "sterilization" in a bacteriologic sense, other than in their correct scientific significance; that is, meaning the absence or destruction of all microorganisms. These terms are not relative. Their use in a relative sense is not only incorrect, but also opens the way for abuse and misunderstanding. In the case of human tissue, it is questionable whether there are any chemical agents which will produce sterility, although there are some which may reduce the bacterial flora of the skin to such an extent that they may properly be described as disinfecting agents. For such agents, there is no objection to the use of the terms "disinfecting," "bactericidal" and "bacteriostatic," all of which may be used in a relative sense. An appreciation of careful nomenclature, as the Council has noted elsewhere (J.A.D.A., 23:1367, July 1936) leads to a better understanding of fundamental processes.

LOCAL ANESTHETICS

After the last meeting of the Council, it was pointed out that:

> The Council agrees, on the basis of common information, that those solutions which approach the normal tissues in terms of p_H may be preferable, but no one has as yet sufficiently defined the exact p_H range at which the most effective local anesthesia is obtainable. No one has demonstrated a definite or important difference in solutions having a p_H, for example, of 5.5, 6.5, 7 or 7.2. The Council, therefore, cannot acquiesce in any claims made for the buffering action of local anesthetic solutions until more convincing evidence is available. (J.A.D.A., 23: 1559, August 1936.)

Despite the fact that the Council cannot acquiesce in any claims made for the buffering action of local anesthetic solutions until more convincing evidence is available, certain manufacturers continue to make claims of superiority for a supposedly buffered solution, although, to be sure, with less emphasis than formerly. Within the last year, the term "buffered" is losing some of its popularity, and there appears to be an attempt to replace it by the word "alkaline." In order that the members of the Council may be guided in the consideration of the claims which may be made for alkaline solutions, the three common claims were presented: (1) they have the p_H of blood; (2) they are less toxic (than acid solutions, the p_H range not being stated), and (3) they induce prompter anesthesia. Only the first of these could be considered acceptable, and only then when the p_H is that of the blood, namely, 7.2-7.4. No convincing evidence has been made available that they are less toxic or that they induce prompter anesthesia. A comprehensive report by Tainter and Moose (J.A.D.A., 24:376, March 1937) shows little difference in the action of procaine at p_H levels 5.6 (acid) and 8.1 (alkaline).

Note should be made of improvement in the technic of depositing local anesthetic solutions. Formerly, it was not uncommon practice to inject several cubic centimeters in one minute or even less time. It has been observed at clinics of those promoting alkaline local anesthetic solutions that the time for injection of the solution is lengthened to four and even six minutes. After this better technic, one would expect less so-called shock, quicker inducement of anesthesia and, generally speaking, more satisfactory anesthesia.

As pointed out above, no carefully controlled experimental evidence has been made available that the factor of alkalinity or acidity is important over and above ordinary prudence in the injection of the solution. The Council's own position is best expressed by the circumstance that it has admitted to Accepted Dental Remedies local anesthetic solutions having a p_H over a relatively wide range, that is from 4 to 7.8.

STERILITY OF LOCAL ANESTHETIC SOLUTIONS

The Council demands, as a condition of acceptance for stock solutions of local anesthetics, evidence that the product is tested for sterility before release. The Council has provided no particular method. As a result of the number of inquiries that are received from manufacturers, the Council suggests that a method such as is described in National Formulary VI, page 26, or a better one, will be acceptable.

ARSENICALS, BISMUTH COMPOUNDS, ETC., USED IN THE TREATMENT OF PERIODONTOCLASTIC DISEASE

A tabulation of the drugs used in the treatment of periodontoclastic diseases makes an imposing list. The medicaments range from products as mild as water or glycerin to products as escharotic as chromium trioxide. Practically every conceivable class of drug that has been applied locally has been used in the treatment of these diseases.

Vincent's infection is probably the most studied of all the diseases of the gums. The etiology of Vincent's infection is clearer than that of those diseases which are termed pyorrhea. Because of the supposed relationship of the organism associated with syphilis and those associated with Vincent's infection, the use of arsenicals and bismuth compounds locally for the treatment of these oral conditions has been common practice since the World War. These were referred to as "specifics" by those who were careless with the use of language. It is held by some that despite the circumstance that the use of arsenicals is wholly empiric, the good effects obtained from their use warrant their application. On the other hand, there are critical students who hold that the arsenical therapy of so-called Vincent's infection is based on two unproven assumptions: (1) that these infections are spirochetal infections, and (2) that the arsenicals are spirocheticidal when topically applied. In both of these cases, there is evidence to the contrary. This form of therapy may be regarded as empiric, and the clinical reports on its use are not altogether convincing evidence that the improvement is due to the drug.

The great harm in such practice is that the more valuable and generally acceptable operative procedures for treatment are supplanted or postponed. Consequently, the question arises, "Should not these products be deleted from Accepted Dental Remedies?"

It is believed that Accepted Dental Remedies gives a fair estimate of their present usefulness; namely, that they have been used with some degree of usefulness even though their use is based on empiricism. That they are not "specific" is indicated by the development of Vincent's infection by those receiving arsenicals in the treatment of syphilis. The frequency of reports of usefulness, however, does not permit action to delete them at the present time.

In order that the Council may proceed with the problem conservatively, it will undertake the formation of a committee of members of the Council and outsiders who have had experience in the treatment of these diseases, to consider the etiology, the symptomatology, the geographic distribution and the treatment, with special reference to the relative usefulness of operative procedures and drugs. The Council will announce this special committee of collaborators at a future date.

VITAMIN C

In August, 1936, the Council pointed out that no clinical evidence is available that faulty tooth development in the human being is inhibited by the use of crystalline vitamin

C, or that gingivitis, dental caries, pyorrhea or nonspecific gingivitis is prevented or corrected by the administration of this product. On the other hand, the Council pointed out that experimental deficiencies of vitamin C in animals may lead to abnormal or pathologic conditions of the gums and teeth. The evidence available at that time did not permit outright statements as to its usefulness for the dental conditions enumerated in the promotion of a product which was the subject of comment by the Council. (J.A.D.A., 23: 1554, August 1936.)

The member of the Council in charge of this class of products reviewed the present evidence and pointed out that there was no reason for a revision of that position.

An investigation with which a member of the Council in charge of this class of products is in contact indicates that there is apparently no relation between vitamin C and ordinary gingivitis. The tests which are being made, however, indicate that a relatively large proportion of the number of people examined are deficient in vitamin C, with mild symptoms of scurvy. These patients can be divided into two classes: children of very poor households, who do not have sufficient vitamin-C-bearing foods, and those who have organic disorders. Where there is nothing organically wrong, the lack of vitamin C can readily be corrected. Those who lack vitamin C because of organic conditions which make it difficult for them to utilize vitamin-C-containing foods are in need of medical attention, even though one of the symptoms may be some form of gingivitis.

In view of the foregoing, the Council decided that it would not admit crystalline vitamin C or cevitamic acid to Accepted Dental Remedies at the present time. The Council believed that in view of the experimental position of crystalline vitamin C, it would make no objection to advertisements pointing out the availability of brands of cevitamic acid accepted by the Council on Pharmacy and Chemistry, for such experimental applications as dentists may care to undertake.

TARTAROFF

In 1928 and in 1935, the A.D.A. Bureau of Chemistry[1] and the Council on Dental Therapeutics[2] had reports on Tartaroff. These reports asserted that Tartaroff could not be used with impunity. The following stipulation in a press release of the Federal Trade Commission may be interesting to readers of THE JOURNAL:

The Tartaroff Co., 1640 Fulton St., Chicago, agrees to stop asserting in advertising that Tartaroff is a new, amazing, liquid discovery that whitens teeth instantly or is a new, secret formula that makes teeth pearly white and sparkling instantly, and other similar representations. In its stipulation, the respondent admits that, according to reliable medical authority, some deposits of tartar are so located in relation to the teeth and gums that they cannot readily be attacked by acids and these acids cannot be held in contact with the tartar for a sufficient time to remove it. According to the respondent company's admission, the only adequate method for removing some tartar deposits is by instrumentation (scraping).

1. "Tartaroff." J.A.D.A., 15:2167, November 1928.
2. "Tartaroff, Not Admissible to Accepted Dental Remedies." J.A.D.A., 22:315, February 1935.

RECENT BOOKS WORTH BORROWING* OR BUYING†

from the

LIBRARY BUREAU

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AMERICAN DENTAL ASSOCIATION

212 E. Superior St., Chicago, Ill.

ADAMS, C. W.: Your teeth and their care. St. Louis: Mosby, 1932. $1.25.

———— Alfred David Lenz system of lost wax casting. New York: National Sculpture Soc., 1933. $2.00.

ALY, BOWER: Socialized medicine: ninth annual debate handbook, 2 vols. Columbia, Mo.: Lucas Bros., 1935. 75c each.

AMERICAN ASSN. DENTAL SCHOOLS: Course of study in dentistry. Chicago: Amer. Assn. Dental Schools, 1935. $1.00 paper, $1.50 cloth.

AMERICAN DENTAL ASSN., COUNCIL ON DENTAL THERAPEUTICS: Accepted dental remedies. Chicago: American Dental Assn., 1935. $1.00.

AMERICAN MEDICAL ASSN., BUREAU MED. ECONOMICS: Handbook of sickness insurance, state medicine and the cost of medical care. Chicago: Amer. Med. Assn., 1934. 35c.

AMERICAN MEDICAL ASSN., COUNCIL ON PHARMACY & CHEMISTRY: Glandular physiology and therapy. Chicago: Amer. Med. Assn., 1935. $2.50.

AMERICAN MEDICAL ASSN., COUNCIL ON PHARMACY & CHEMISTRY: New and nonofficial remedies, 1935. Chicago: Amer. Med. Assn., 1935. $1.50.

AMERICAN PHARMACEUTICAL ASSN.: National formulary. Washington, D. C.: Amer. Pharmaceutical Assn., 1935. $5.00.

AMERICAN PHARMACEUTICAL ASSN. Pharmaceutical recipe book. Baltimore, Md.: Amer. Pharmaceutical Assn., 1936. $5.00.

AMERICAN PHARMACEUTICAL ASSN.: Year book of the American Pharmaceutical Association, 1934. Washington, D. C.: Amer. Pharm. Assn., 1936.

ANDERSON, G. M.: Orthodontic laboratory manual. St. Louis: Mosby, 1930. $2.00.

ANTHONY, L. P.: Dental terminology. Chicago: American Dental Assn., 1930.

APPLETON, J. L. T., JR.: Bacterial infection with special reference to dental practice. Philadelphia: Lea & Febiger, 1933. $7.00.

APPLETON, J. L. T., JR., & BRYANT, C. K.: Laboratory guide in bacteriology. Philadelphia: Lea & Febiger, 1928. $2.75.

ASGIS, A. J.: Outline of dental socio-economics. New York: Allied Dental Council, 1934. $1.00.

BAILEY, HAMILTON: Clinical surgery for dental practitioners. London: H. K. Lewis & Co., Ltd., 1937. $4.00.

BARTELS, H. A.: Outline of bacteriology. New York: W. A. Broder, 1929. $2.00.

BARTLETT, L. W., & NEEL, MILDRED B.: Compensations in the professions. New York: Association Press, 1933. $2.00.

BECK, DOROTHY F.: Cost of equipping a dental office. Chicago: University of Chicago Press, 1932. $1.00.

BERGER, ADOLPH: Principles and technique of oral surgery. Brooklyn, N. Y.: Dental Items of Interest, 1927. $7.00.

BERGER, ADOLPH: Principles and technique of the removal of teeth. Brooklyn, N. Y.: Dental Items of Interest, 1929. $7.50.

BEUST, T. B.: Dental histology and embryology. Philadelphia: Saunders, 1934. $3.00.

BIRCH, C. L.: Hemophilia—clinical and genetic aspects. Urbana, Ill.: Univ. of Illinois, 1937. $2.00 paper, $2.50 cloth.

BLACK, A. D.: G. V. Black's work on operative dentistry with which his special dental pathology is combined. 4 volumes. V. 1—Pathology of hard tissues of teeth;

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*Books may be *borrowed* by members of the Association for a period of one week after date of receipt; if not reserved for some one else, the period will be extended on request. A deposit of $2.00 for each volume to be sent at one time should accompany all requests for books. This will be refunded on return of books.

†If you wish to *purchase* books, indicate plainly which books you desire and enclose check with order. In order to conserve space, only books published from 1927 to date are included in this list.

oral diagnosis. V. 2—Technical procedures in making restorations in teeth. V. 3—Treatment of dental caries. V. 4—Diseases and treatment of investing tissues of teeth and other soft tissues of mouth. Chicago: Medico-Dental Publishing Co., 1936. Complete set $16.00, $4.50 per volume.

BLAIR, V. P., & IVY, R. H.: Essentials of oral surgery. St. Louis: Mosby, 1936. $6.50.

BLAYNEY, J. R.: Dental pharmacology and therapeutics. St. Louis: Mosby, 1936. $4.00.

BLUNT, KATHERINE, & COWAN, RUTH: Ultraviolet light and vitamin D in nutrition. Chicago: University of Chicago Press, 1930. $2.50.

BODECKER, C. F.: Elementary histology for dental hygienists. New York: W. A. Broder, 1929. $2.00.

BOGERT, L. J.: Nutrition and physical fitness. Philadelphia: Saunders, 1935. $3.00.

BOSWORTH, H. J.: Dental economics. Chicago: Bosworth Economic Institute, 1932. $3.00.

BOWLER, INEZ: Elementary manual of dental library practice. Ann Arbor: Univ. of Michigan Press, 1932. $1.50.

BOX, H. K.: Necrotic gingivitis. Toronto: University of Toronto Press, 1930. $1.25.

BOX, H. K.: Treatment of the periodontal pocket. Toronto: University of Toronto Press, 1928. $1.25. (Out of print.)

BOYLE, H. H.: Principles and practice of applied dental aesthetics. London: Kimpton, 1936. $6.25.

BREGSTEIN, S. J.: Business conduct of an ethical practice. Brooklyn, N. Y.: Dental Items of Interest, 1932. $4.00.

BRIDGES, M. A.: Dietetics for the clinician. Philadelphia: Lea & Febiger, 1935. $10.00.

BRODERICK, F. W.: Principles of dental medicine: the medical aspects of dental disease. St. Louis: Mosby, 1936. $7.50.

BROTHERS, E. D.: Dental jurisprudence. St. Louis: Mosby, 1928. $2.25.

BROWN, A. J.: Dental metallurgy. Outlines of dental science. Vol. 11. New York: Wood, 1928. $2.50.

BROWN, W. L.: Endocrines in general medicine. New York: Hoeber, 1927. $3.00.

BULLEID, ARTHUR: Textbook of bacteriology for dental students. St. Louis: Mosby, 1927. $4.50.

BUNCE, E. W.: Bunce-Kanouse full denture technic. Chicago: Coe Laboratories, Inc., 1929. $1.25.

BUNTING, R. W.: Oral hygiene and the treatment of parodontal diseases. Philadelphia: Lea & Febiger, 1936. $2.50.

BUNTING, R. W.: A textbook of oral pathology for students and practitioners of dentistry. Philadelphia, Lea & Febiger, 1929. $7.00.

BURKHART, H. J.: Care of the mouth and teeth. (National Health Series.) New York: Funk & Wagnalls, 1928. $0.30.

BUXTON, J. L. D.: Dental pathology. Outlines of dental science. Vol. 7. New York: Wood, 1927. $2.50.

BUXTON, J. L. D.: Dental surgery. Outlines of dental science. Vol. 8. New York: Wood, 1927. $2.50.

CABOT, HUGH: Doctor's bill. New York: Columbia University Press, 1935. $3.00.

CAHN, L. R.: Basic principles of general oral pathology. Brooklyn, N. Y.: Dental Items of Interest, 1929. $4.50.

CAMPBELL, HARRY: What is wrong with British diet. London: Heinemann, 1936. $3.25.

CAMPBELL, MENZIES: Those teeth of yours. London: Heinemann, 1931. $1.50.

CASTO, T. D.: Questions and answers on pedodontology, with glossary. Philadelphia: Author, 1932. $2.50.

CATTELL, PSYCHE: Dentition as a measure of maturity. Cambridge: Harvard University Press, 1928. $1.00.

CHASE, STUART, FAIRCHILD, H. P., & OVERSTREET, A. C.: Rich man, poor man. New York: Harper, 1935. $1.00.

CHILDS, LESLIE: Law for the dentist. Philadelphia: S. S. White, 1934.

CHRISTIE, A. C.: Economic problems of medicine. New York: Macmillan, 1935. $2.00.

CHURCHILL, H. R.: Human odontography and histology. Philadelphia: Lea & Febiger, 1932. $4.50.

CHURCHILL, H. R.: Meyer's normal histology and histogenesis of the human teeth and associated parts. Philadelphia: Lippincott, 1935. $4.50.

COGSWELL, W. W.: Dental oral surgery. Pittsburgh, Pa.: Dental Digest, Inc., 1932. $10.00.

COLYER, J. F. & SPRAWSON, EVELYN: Dental surgery and pathology. New York: Longmans, 1931. $12.50.

COMMITTEE ON COSTS OF MEDICAL CARE: Medical care for the American people. Chicago: Univ. of Chicago Press, 1932. $1.50.

COOK LABORATORIES: Manual of local anesthesia in general dentistry. New York: Cook Laboratories, Inc., 1936.

DALL, WILLIAM: Ground porcelain inlays. London: Henry Kimpton, 1933. $5.25.

DARLINGTON, C. G., WILSON, G. W., ET AL.: Year book of dentistry, 1936. Chicago, Ill.: Year Book Pub., 1936. $3.00.

DAVIS, ADELLE: Optimum health. Los Angeles: California Graphic Press, 1935. $2.50.

DAVIS, M. M.: Paying your sickness bills. Chicago: University of Chicago Press, 1931. $2.50.

DENTAL BOARD OF THE UNITED KINGDOM: Three lectures on "dental alloys." Delivered under the auspices of the Dental Board of the United Kingdom. London: Dental Board of the United Kingdom, 1927. $2.00.

DEWEY, MARTIN, & ANDERSON, G. M.: Practical orthodontia. St. Louis: Mosby, 1935. $8.50.

DIAMOND, M.: Dental anatomy: a graphic presentation of tooth forms, etc. New York: Macmillan, 1935. $4.00.

DILLING, W. J., & HALLAM, SAMUEL: Dental materia medica, pharmacology and therapeutics. London: Cassell & Co., 1935. $3.25.

DISRAELI, I.: Vincent's disease, pyorrhea and allied subjects. Los Angeles, Calif.: Dental Research Pub. Co., 1935. $6.00.

DORRANCE, G. M.: Operative story of cleft palate. Philadelphia: Saunders, 1933. $6.50.

DOXTATER, L. W.: Full and partial denture prosthesis. Brooklyn, N. Y.: Dental Items Interest, 1936. $6.00.

DOXTATER, L. W.: Procedures in modern crown and bridge-work. Brooklyn, N. Y.: Dental Items of Interest, 1931. $8.00.

DUNNING, W. B., & DAVENPORT, S. E.: Dictionary of dental science and art. Philadelphia: Blakiston, 1936. $6.50.

DUTTON, W. F., & LAKE, G. B.: Parenteral therapy. Springfield, Ill.: Thomas, 1936. $7.50.

ENDLEMAN, JULIO: Special dental pathology; a treatise for students and practitioners. St. Louis: Mosby, 1927. $7.00.

ENNIS, L. M.: Dental roentgenology. Philadelphia: Lea & Febiger, 1936. $6.50.

EPSTEIN, ABRAHAM: Insecurity: a challenge to America. New York: Random House, 1936. $4.00.

FALK, I. S.: Security against sickness. New York: Doubleday, Doran, 1936. $4.00.

FARKASCH, O.: Dilemmas of dentistry. New York: Dodd Bros., 1931. $3.50.

FEDERSPIEL, M. N.: Harelip and cleft palate. St. Louis: Mosby, 1927. $5.00.

FELCHER, F. R.: Art of porcelain in dentistry. St. Louis: Mosby, 1932. $9.00.

FELDMAN, M. H.: Manual of exodontia. Philadelphia: Lea & Febiger, 1930. $3.50.

FERGUSON, H. W.: Child's book of the teeth. Yonkers-on-Hudson: World Book Co., 1932. $0.68.

FINE, SAMUEL: Principles and practice of dental assistant. Worcester, Mass.: Hamilton Pub. Co., 1931. $2.50.

FISCHER, GUIDO: Local anesthesia in dentistry. Philadelphia: Lea & Febiger, 1933. $4.00.

FISH, E. W.: Experimental investigation of enamel, dentine and the dental pulp. London: John Bale, Sons & Danielsson, Ltd., 1933.

FISH, E. W.: Principles of full denture prosthesis. London: John Bale, 1933. $4.00.

FONES, A. C.: Mouth hygiene; a textbook for dental hygienists. Philadelphia: Lea & Febiger, 1934. $5.00.

FOOTE, J. S.: Bone as a measure of development: When and how we acquired our teeth. Chicago: American Dental Association, 1928. $2.00.

FRAHM, F. W.: Principles and technics of full denture construction. Brooklyn, N. Y.: Dental Items of Interest, 1934. $7.00.

FRANZEN, RAYMOND: Public health aspects of dental decay in children. New York: American Child Health Assn., 1930. $1.25.

GILLETT, H. W., & IRVING, A. J.: Gold inlays by the indirect system. Brooklyn, N. Y.: Dental Items of Interest, 1932. $8.00.

GOEPP, R. M.: Dental state board questions and answers. Philadelphia: Saunders, 1928. $4.50.

GOTTLIEB, B., & ORBAN, B.: Die veränderungen der gewebe bei übermässiger beanspruchung der zähne. Leipsic: Georg Thieme, 1931. Unbound, $6.50. Bound, $7.00.

GRAVES, LULU G.: Foods in health and disease. New York: Macmillan, 1932. $3.50.

GREENFIELD, A. L.: X-ray technic and interpretation of dental roentgenograms. Brooklyn, N. Y.: Dental Items of Interest, 1936. $6.00.

GREGORY, W. K.: Our face from fish to man. New York: Putnam, 1929. $4.50.

GWATHMEY, J. T.: Textbook of anesthesia. New York: Macmillan, 1929. $7.50.

GWINN, C. D.: Textbook of exodontia. Philadelphia: Lea & Febiger, 1927. $2.75.

GYSI, ALFRED: Special teeth for cross-bite cases. New York: Dentists' Supply Co., 1928. (Pamphlet.) (No purchase orders accepted.)

HACKH, I. W. D.: Chemical reactions and their equations. Philadelphia: Blakiston, 1928. $2.00.

HADEN, R. L.: Dental infection and systemic disease. Philadelphia: Lea & Febiger, 1936. $2.50.

HALL, E. M.: Pulpless tooth problems. Detroit, Mich.: Detroit Dental Manufacturing Co., 1930.

HANAU, R. I.: Hanau intraoral method vs. Gysi extraoral method. Buffalo, N. Y.: Author, 1927. (No purchase orders accepted.)

HANKE, M. T.: Diet and dental health. Chicago: Univ. of Chicago Press, 1933. $4.00.

HARDER, O. E.: Modern dental metallography. Minneapolis, Minn.: Burgess-Roseberry Co., 1930. $3.75.

HARRIS, L. J.: Vitamins in theory and practice. New York: Macmillan, 1935. $3.00.

HARROW, BENJAMIN, & SHERWIN, C. P.: Textbook of biochemistry. Philadelphia: Saunders, 1935. $6.00.

HARTMAN, L. L.: Teeth and the mouth. New York: Appleton, 1927. $1.50.

HAYES, L. V.: Clinical diagnosis of mouth diseases. Brooklyn, N. Y.: Dental Items of Interest, 1935. $7.50.

HEDSTROM, GUSTAV: Gangrene of dental pulp and its treatment. Stockholm, Sweden: Isaac Marcus, 1927. (No purchase orders accepted.)

HEADRIDGE, DAVIS, & GIBSON, S. K.: Dental anatomy, human and comparative. Outlines of dental science. Vol. 6. New York: Wood, 1928. $2.50.

HERBST, EMIL, & APFFELSTEADT, MAX: Atlas und grundiss der missbildungen der kiefer und zähne. Munich, Germany: J. F. Lehmanns, 1928. (No purchase orders accepted.)

HESS, A. F.: Collected writings. 2 vols. Springfield, Ill.: Thomas, 1936. $15.00.

HEWER, C. L.: Recent advances in anaesthesia and analgesia. Philadelphia: Blakiston, 1932. $3.50.

HILDEBRAND, G. Y.: Studies in masticatory movements of human lower jaw. Berlin: Gruyter, 1931. (No purchase orders accepted.)

HODGEN, J. D.: Practical dental metallurgy. St. Louis: Mosby, 1932. $3.75.

HOGEBOOM, F. E.: Practical pedodontia or juvenile operative dentistry and public health dentistry. St. Louis: Mosby, 1933. $6.50.

HOKE, C. M.: Testing precious metals: gold, silver, palladium, platinum; identifying, buying, selling. New York: Jewelers Technical Advice Co., 1935. $1.00.

HOLLIDAY, HOUGHTON: Dental radiology handbook. New York: Macmillan, 1935. $2.00.

HOMANS, JOHN: Textbook of surgery. Springfield, Ill.: Chas. C. Thomas, 1936. $8.00.

HYATT, T. P.: Hygiene of mouth and teeth. Brooklyn, N. Y.: Brooklyn Dental Pub. Co., 1929. $1.00.

HYATT, T. P.: Prophylactic odontotomy: A practical and simple procedure for the prevention of caries in pit and fissure cavities. New York: Macmillan, 1933. $1.50.

IVY, R. H., & CURTIS, LAWRENCE: Fractures of the jaws. Philadelphia: Lea & Febiger, 1931. $4.50.

JAMIESON, J. D. H.: Operative dentistry. Outlines of dental science. Vol. 9. New York: Wood, 1927. $2.50.

JERMAN, E. C.: Modern x-ray technic. St. Paul: Bruce Pub. Co., 1928. $5.50.

JOHNSEN, JULIA E.: Socialization of medicine. Vol. 10. (Reference Shelf.) New York: Wilson, 1935. $0.90.

JORDAN, E. O.: Textbook of general bacteriology. Philadelphia: Saunders, 1935. $6.00.

JORDON, M. EVANGELINE: Operative dentistry for children. Brooklyn, N. Y.: Dental Items of Interest, 1927. $5.00.

JUTTE, M. E.: You must eat meat. New York: Putnam, 1936. $2.00.

KANNER, LEO: Folklore of the teeth. New York: Macmillan, 1928. $4.00.

KENNEDY, EDWARD: Partial denture construction. Brooklyn, N. Y.: Dental Items of Interest, 1928. $7.50.

KENT, E. N.: Business side of dentistry. St. Louis: Mosby, 1929. $5.00.

KNAPP, K. W.: Manual of fixed bridgework. New York: New York Univ. Press, 1935. $3.00.

KORKHAUS, GUSTAV: Moderne orthodontische therapie. Berlin: Meusser, 1932.

KRAETZER, A. F.: Your long-suffering stomach. New York: McBride, 1933. $1.50.

KRONFELD, RUDOLF: Histopathology of the teeth and their surrounding structures. Philadelphia: Lea & Febiger, 1933. $7.00.

KUTTLER, YURY: Mis investigaciones sobre la denticion en 15,240 ninos y 782 adultos habiendo hecho 28,557 examenes. Mexico, D. F.: Facultad Odontologica de la Universidad Nacional Autonoma de Mexico, 1933.

LAMB, RUTH DE F.: American chamber of horrors. New York: Farrar & Rinehart, 1935. $2.50.

LEE, R. I., & JONES, L. W.: Fundamentals of good medical care. Chicago: Univ. of Chicago Press, 1933. $2.50.

LERICHE, R., & POLICARD, A.: Normal and pathological physiology of bone. St. Louis: Mosby, 1928. $5.00.

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CURRENT LITERATURE

A Case of Absence of Salivary Secretion

By H. S. Sharp

A boy, aged 8, suffered from dry mouth and soreness of the lips. He could not spit and had to sip water in order to masticate and swallow dry foodstuffs. The mucous membranes were dry and the gums retracted, and the lower molars were carious. The orifice of Stenson's (parotid) duct was absent on both sides and only one of Wharton's ducts was present. The orifices to the sublingual glands were present. Testing with fruit juice and pilocarpine failed to reveal salivary secretions. The lachrymal and sweat glands were normally active and there was no evidence of other physical abnormalities. There was no hereditary factor. Reports of similar cases are listed. —*J. Laryng. & Otol.*, 52:177, 1937.

Basil G. Bibby.

Carcinoma of the Tongue

By F. R. Spencer

Although cancer of the tongue is a particularly painful and a fatal type of malignancy, care should be taken not to permit patients to fear cancer because of fissured tongues. Carcinoma of the tongue is rare in a clean mouth, and oral sepsis can be held as a cause or as a complicating factor. Fourteen cases are reported by the author, thirteen in men. The ages ranged from 42 to 80, with 64 as an average. Race seemed of little consequence. Only one patient was known to be syphilitic, thirteen, including this patient, giving negative Wassermann reactions. One was not given a test. Only four biopsies were made, three showing squamous-cell carcinoma. In one, there was insufficient material for diagnosis. There was cervical glandular involvement in six cases. One tumor was on the tip of the tongue, the others were on the sides (five right, six left). Five of the tongues were ulcerated, three had nodules, three had warty growths, two had fissures and one was excoriated. None of the patients were treated by surgical removal, but eleven received roentgen therapy. Radium needles were used. One was removed by electrocoagulation and one reduced by the use of carbon dioxide snow. Of the fourteen cases reported, eleven of the patients were traced after leaving the hospital. Not one of these lived five years after treatment. The author concludes that recognition of the importance of syphilis and of carious teeth and poor dental hygiene in the etiology of these tumors will do much to prevent and relieve suffering from lingual carcinoma.—*Arch. Otolaryng.*, 24:1, July 1936.

Hamilton Robinson.

Experimental Radium Poisoning. (II) Changes in the Teeth of Rabbits Produced by Oral Administration of Radium Sulfate

By M. Rosenthal

In rabbits given radium sulfate, orally, not only were changes produced in the alveolar bone, but also in the teeth themselves. The animals were kept on a normal and adequate diet throughout the experiment. No change was noted in the first two months of the experiment, but in the third month brown mottling appeared. There was a general progressive disturbance in calcification, with the resorption of the teeth and formation of ankyloses by the ingrowth of newly formed bone in the alveolar process. Progressive degeneration and necrosis was noted in the enamel organ and the pulp tissue was replaced by irregular secondary dentin masses. The surrounding periodontium showed extreme hyperplasia of fibroblastic tissue invading the surrounding structures. It is interesting to note the finding of cysts developing from epithelial rests in the periodontium.—*Am. J. M. Sc.*, 193:495, April 1937.

V. D. Cheyne.

Persistent Sinus Tracts of Dental Origin

By N. P. Anderson

The author calls attention to a condition known to dentists, but apparently not readily recognized by dermatologists and neglected in dermatologic literature. Three cases of sinus tracts from periapical lesions to the chin, cheek and gingiva are cited. The etiology of dental abscess and of sinus tracts from teeth is given, the author quoting freely from the dental literature. It is pointed out that the sinus tract may lead to the chin, cheek, neck, antrum, nasal cavity, oral cavity, clavicular region or eye.—*Arch. Dermat. & Syph.*, 35:1062, June 1937.

Hamilton Robinson.

Unusual Tumor Involving the Maxillary Antrum

By B. L. Bryant

The literature on tumors of dental origin is briefly reviewed and a case is reported of a cystic tumor removed from the antrum of a man twenty-eight years old. A swelling in the left maxillary third molar region was first noticed four years after the uneventful removal of the second molar in that area. A fistula was present over the third molar. The tumor was removed at a radical antrum operation, and the material was reported by the pathologic laboratory as dense fibrous tissue lined with several layers of circular epithelial tissue, with inflammatory cell infiltration, but no evidence of neoplasia. The author believes that the tumor was unquestionably of dental origin.

Hamilton Robinson.

Some Tumors and Ulcers of the Palate and Fauces

By W. Howarth

It is believed that mixed tumors of the palate, probably derived from fully developed glandular tissue, are more common than is generally thought. They usually can be shelled out readily, and this is done preferably with a diathermy knife. Hemangioma and hemangiofibroma are rare in the palate, but the possibility of dealing with this type growth should always be considered. Fatty tumors are extremely rare in the palate and the author has encountered only one adenoma. Adenocarcinoma is slow growing in the roof of the mouth. True osteoma is rarely seen, bony palatal growth being, in most cases, torus palatinus. The author's cases of epithelioma include extension from the tonsil to the palate or to the palate and tongue and the purely palatal type. In sixty-one cases of malignancy of the palate and fauces, 36 per cent of the patients died within the first year and 39 per cent between one and five years, 24 per cent surviving more than five years. The author's operation is described. Streptococcic ulcers, tuberculous ulcers and Vincent's ulcers are considered. Three cases of precancerous epitheliomatosis with multiple papular eroded swellings or flat cellular papillomatous areas that were whitish, with a milky pellicle, are described. The cases cited are illustrated by thirty drawings and photographs, mostly in full color. —*J. Laryng. & Otol.*, 52:1, January 1937.

Hamilton Robinson.

Malignant Disease of the Upper Jaw

By G. Ohngren

In treatment of malignancy, the operator should bear in mind that it is better to keep the patient alive for five years with a visible scar rather than to allow him to die earlier without a noticeable scar. Electroendothermy is the author's method of choice. Removal of decayed teeth and eliminating infected material from the tonsils is recommended as appropriate preparation. The majority of the patients are also treated with irradiation, applied preoperatively and postoperatively by the roentgen rays and teleradium and by introduction of radium into the wound after coagulation. One hundred twenty cases of maxillary malignancy have been followed for five or more years. Thirty-five per cent of the patients have been living five to twelve years without a recurrence. Ninety-one of these cases were treated by endothermy and irradiation and twenty-nine by endothermy alone. Fifty-eight per cent of the patients treated by endothermy only survived for five to twelve years; which

leads to the conclusion that irradiation does not excel endothermy. More careful antral exploration, more frequent roentgen-ray examination and biopsy in the case of pain in the trigeminal area, nasal obstruction, nasal bleeding or purulent secretions should lead to earlier diagnoses.—*J. Laryng. & Otol.*, 52:18, January 1937.

HAMILTON ROBINSON.

Partial Gigantism of Face and Teeth

By M. A. RUSHTON

A CASE of a child with one side of the face much larger than the other is reported and diagnosed as partial gigantism. Five other cases are reported from the literature and a comparison is made. In summary, the author says: "The condition, which is not known to be inherited or familial, starts *in utero*, and enlargement of one side of the face is noticed at birth. On that side the upper and lower jaw, alveolar processes, cheek and lip are enlarged, and often also the ear, anterior part of the tongue, and zygomatic arch. The deciduous teeth erupt early and are early replaced by the permanent set. Of the deciduous teeth enlargement is found in the second molars: in the permanent series the greatest and most constant enlargement is seen in the canines, but there may also be some in the first molars and other teeth excepting the incisors and second and third molars. One or more permanent teeth in the molar region of the affected side may be absent or small. In some tissues the enlargement continues after the normal growth period has ended."—*Brit. D. J.*, 62:572, June 1, 1937.

BASIL G. BIBBY.

MISCELLANY

CONGRES DES CHIRURGIENS-DENTISTES DE LANGUE FRANCAISE DE L'AMERIQUE DU NORD

THE French-speaking dentists of North America held their third convention in Montreal, Canada, on May 27-29, 1937, under the auspices of the Alumni Association of the Faculty of Dentistry of the University of Montreal. The registration was heavy, more than 400 French-speaking dentists from Canada and the United States taking part in the proceedings. Lectures were delivered and table clinics held by many well-known dentists from Montreal and other parts of the Province of Quebec. Several physicians were also on the program as lecturers.

One of the main features at the Convention was the presentation of moving picture films illustrating different technics in the various departments of the dental profession. One film in particular attracted special attention. It was entitled: "The Construction of an All-Porcelain Bridge—Full Technique." This wonderful film was presented by Drs. Sarrazin and Larue, of Montreal.

Among the lecturers and clinicians were: Ernest Charron, past-president of the Quebec Dental Board; Eudore Dubeau, dean of the Faculty of Dentistry, University of Montreal; Alcide Thibaudeau, Theodore Coté, A. Bédard, A. L'Archevêque, Paul Geoffrion, Viger and Gérard Plamondon, Lucien Reeves, Yves Lafleur, De Montigny, P. E. Poitras and several others.

The convention ended in a round table discussion over some important dental problems. Paul Geoffrion, well-known Montreal orthodontist, was elected president of the alumni association for the coming year.

The association of the French-speaking dentists of North America, the only one of its kind in America, is doing its best for the survival of French culture in North America as well as for the advancement of the profession of dentistry.

DEATHS

Baker, Mark L., Toledo, Ohio; University of Michigan, College of Dental Surgery, 1910; died May 22; aged 51.

Beal, Nelson, Springfield, Utah; Northwestern University Dental School, 1919; died of cerebral hemorrhage, May 4; aged 41.

Drake, E. L., Marquette, Mich.; University of Michigan, College of Dental Surgery, 1887; died March 15; aged 75.

Gerhold, Elsa Juliane, Chicago, Ill.; Northwestern University Dental School, 1910; died May 21. Dr. Gerhold was born in Vienna and returned there after her graduation to associate herself with her father, Anton Gerhold, in the practice of dentistry. On the death of her father, in 1913, she returned to Chicago. Dr. Gerhold was a member of the Chicago Dental Society, the Chicago Club of Women Dentists and the honorary fraternity of Omicron Kappa Upsilon.

Graves, Robert M., Klamath Falls, Ore.; Ohio College of Dental Surgery, University of Cincinnati, 1913; died March 12; aged 52.

Hess, Wendell Holmes, Fairmont, W. Va.; University of Pittsburgh, School of Dentistry, 1916; died March 15.

Hicks, Charles H. S., Philadelphia, Pa.; Pennsylvania College of Dental Surgery, 1900; died April 18.

Mangold, Daniel Burt, Decatur, Ind.; Indiana University School of Dentistry, 1905; died recently; aged 53.

Marshall, Nathan W., Chicago, Ill.; Chicago College of Dental Surgery, 1919; died May 25; aged 45.

Newhouse, Richard, Franklin, Ind.; Indiana University School of Dentistry, 1883; died March 19; aged 80.

Slade, Samuel C., Vineland, N. J.; Pennsylvania College of Dental Surgery, 1886; died March 19; aged 88.

Thomssen, Norman F., Detroit, Mich.; University of Michigan, College of Dental Surgery, 1919; died March 29; aged 49.

Wagner, Samuel, Galion, Ohio; Baltimore College of Dental Surgery; died February 7; aged 99.

DR. RODRIGUES OTTOLENGUI AND COLONEL ROBERT T. OLIVER

TWO prominent members of the American Dental Association passed away at the time of the A. D. A. meeting, July 11th, Colonel Robert Todd Oliver, Past President of the Association and head of the Army Dental Corps during the World War, and Dr. Rodrigues Ottolengui, distinguished editor of *Dental Items of Interest,* New York City. More extended notices will appear in a later issue.

INCIDENTS OF PRACTICE

Infection of Deciduous Teeth

By RUDOLF KRONFELD, M.D., D.D.S.
Chicago, Ill.

In the May 1937 issue of THE JOURNAL, page 786, there appeared an article by C. H. Morningstar dealing with the effect of infection of the deciduous teeth on the permanent successors. This report begins with the following statement: "A review of the dental literature reveals not a single paper on periapical inflammation of deciduous teeth and its effect on the enamel organ or the formed enamel of the permanent tooth germ."

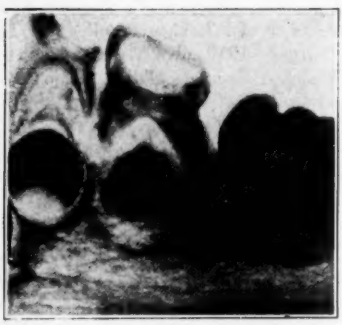

Fig. 1

Wilhelm Bauer, of Innsbruck, Austria, in 1932, and as recently as 1935, described and illustrated several specimens of human jaws, showing how enamel hypoplasia of the permanent teeth is produced by an apical involvement of the deciduous predecessors, and gave a detailed and well-illustrated description of the changes in the tooth follicle, enamel organ and enamel of the affected bicuspids (*Zeitschr. f. Stomatol.* 30:721, 1932; 33:1089, 1935). Bauer's conclusions are identical with those of Morningstar.

Fig. 2

The fact that the paper by Morningstar is a report of work done in Austria, the same country in which Bauer's investigation was carried out and published, makes the omission of any reference to the latter's work and priority the more surprising.

An Orthodontia Case Caused by an Unusual Habit

By IRWIN F. STEUER,* D.D.S., M.S.D.
Cleveland, Ohio

ONE of the most difficult types of cases for the orthodontist to combat is the one in which some pernicious habit is encountered, such as thumb-sucking or finger-sucking, lip-biting or tongue manipulation. It is discouraging enough when the patient has acquired one of these habits, but it is alarming when the child acquires a combination of these habits to the enjoyment of himself, the disruption of his mouth and the despair of the orthodontist.

The following report is of a healthy, apparently normal boy, eleven years of age, who sucks two fingers and his tongue at the same time.

Figure 1 shows the way in which the patient places the fingers in the mouth and protrudes his tongue, and demonstrates the position of the tongue during the sucking motion, which is very much the same as that of a baby when sucking a bottle. The location of the thumb against the cheek also permits more pressure during the sucking movement.

Figures 2 and 3 show clearly the part the sucking habit has played in elongating the tongue. This boy can touch the tip of his nose with ease and can almost reach the lowest portion of his chin.

The open-bite condition brought about by the finger-tongue habit is shown in Figure 4. It will be noted that the mammelons are still present in both the upper and the lower teeth, showing what little use the anterior teeth have been for biting. A surprising observation is that the gingival tissue is in a very healthy condition, owing, no doubt, to the exercise and massage afforded the supporting tissue in sucking.

Fig. 1

Fig. 2

The only occlusion present is that of the first permanent molars, which are in good condition.

The prognosis, from an orthodontic standpoint, is, in this case, very bad. Though the boy is a cooperative patient,

*Associate Clinician in charge of Orthodontia, Mt. Sinai Hospital.

it is difficult to break the habit entirely, and I doubt that our efforts will have a worth-while result, there being much damage to the bony structure. The habit has even caused an elongation of the fingers. We are, of course, trying to do everything possible to restore normal occlusion by the use of orthodontic appliances.

Fig. 3

Fig. 4

I have some interesting moving pictures of this patient, showing the way in which he indulges in this habit of finger-tongue sucking, and the obvious enjoyment he derives from it. Despite his age and normal intelligence, the patient seems quite proud to demonstrate his accomplishment of finger-tongue sucking and will gladly pose for any operator.

Republic Building.

The Dentigerous Cyst: Report of a Case

By ADRIAN R. KRISTELLER, D.D.S.
Newark, N. J.

THE dentigerous cyst is, according to Thoma, the most common type of epithelial cyst and is usually formed any time during the developmental stage up to the formation of the teeth. The only clinical sign is the non-eruption of teeth.

REPORT OF CASE

History.—H. S., a man, aged 22, suffered from a suppurative colitis and general systemic debility. There was no previous dental history except that the upper left second molar was prevented from normal eruption.

Appearance of cyst.

Physical Examination.—A full mouth series of roentgenograms revealed a partly impacted lower right third molar; a totally impacted lower left third molar, and an upper left second molar of retarded eruption. Around the area of the second molar was a hard mass, which gave the appearance of bone structure. On further roentgenographic examination and palpation, diagnosis was made of a dentigerous cyst.

Treatment.—Under an ethyl chloride spray, the tissue was incised, and a straight shank elevator and forceps were applied for the removal of the cyst. The surrounding tissue seemed normal.

Pathologic Examination.—The cyst did

not seem to have any attachment to the second molar and, on its removal, the surface, though greatly marked, was very smooth, as shown in the accompanying illustration.

Subsequent Course.—After removal of the dentigerous cyst, the upper left second molar moved toward normal occlusion.

Comment.—After removal of the cyst, the patient showed a marked improvement in oral hygiene and an increased comfort in mastication, as well as an improved food taste. The colitis seemed to abate slightly and the general systemic symptoms improved.

1180 Raymond Boulevard.

PRACTICE IN PARAGRAPHS

This department is intended for busy readers. It aims to tell a vivid story in a few words. Items should be of a practical character, and free from padding—not more than a paragraph or two. We exact no limit, but two hundred words can tell most of these stories. Send in your ideas; they will be welcome.

Visiting—Visiting accounts for the biggest financial loss in dentistry.—*Charles C. Norris, Oshkosh, Wis.*

Drawer for Gold—A cabinet should have a metal lined drawer for gold work as gold filings are valuable.—*Charles C. Norris, Oshkosh, Wis.*

Stain Remover—Since most dentists use silver nitrate in some form, a bottle of stain remover should be kept close at hand.—*Charles C. Norris, Oshkosh, Wis.*

Code of Numbers—A code of numbers greatly facilitates a busy practice. A number spoken to an assistant can make clear your exact wishes.—*Charles C. Norris, Oshkosh, Wis.*

Cost—A lead pencil is about the most useful instrument in the office. Use it and know what your business is costing you. You cannot run a successful practice by guess.—*Charles C. Norris, Oshkosh, Wis.*

Operating While Seated—Ninety per cent of dental services can be rendered while sitting. A very safe and convenient stool can be had by shortening the legs of an ordinary swivel office stool.—*Charles C. Norris, Oshkosh, Wis.*

Polishing Fillings—A piece of tape is placed at the gingival margin and the matrix put in place, then the amalgam filling is inserted. The tape is in position for cleaning and polishing fillings at gingival margins.—*Charles C. Norris, Oshkosh, Wis.*

Cleaning Instrument Joints—The joints of various instruments such as pliers and forceps often become corroded or gummed up, so to speak, so that they no longer work freely. A small quantity of paint and varnish remover applied in the joint will loosen the débris so that it may be wiped off with a cloth. Additional applications may be made if necessary.—*Lloyd H. Fymbo, Sergeant Bluff, Iowa,*

Limitation of Roentgenogram—While roentgenograms are exceedingly helpful in diagnosing various dental and periodontal lesions, sole reliance should not be placed upon them. There are instances in which the existing lesion is not revealed by the roentgen rays. It should not be forgotten that a roentgenogram shows only one view. Lesions confined to the labial or lingual aspect of the roots will not be revealed by roentgenographic examination.—*James L. Zemsky, 147 Fourth Ave., New York City.*

Percussion in Examination—While percussion may not be the most important procedure in examination, it often proves of value. It consists in striking a tooth with some instrument and noting the type of sound produced. A clear sound usually indicates that the tooth is vital; a dull sound that the tooth tested is pulpless or that a purulent pulp is present. Pericemental involvement is almost invariably ascertained by percussion, since it is always accompanied by pain.—*James L. Zemsky, 147 Fourth Ave., New York City.*

Contraindication to Surgical Interference—It is important to remember that the excessive weakness of the heart's action, which is the predominant feature in shock, is a result of an extreme functional depression of the nervous system; hence, it may always be expected to occur in persons showing anxiety. From this, it is logical to conclude that patients whose physical or mental condition seems to contraindicate surgical interference should rather be subjected to other therapeutics, even though these are known to be less effective.—*James L. Zemsky, 147 Fourth Ave., New York City.*

Importance of Laboratory Examinations—Laboratory findings such as smears and tissue, urine and blood examinations are of inestimable value in surgical diagnosis, and prognosis, and no conscientious and self-respecting practitioner can afford to ignore them. This does not mean that all other diagnostic criteria are to be disregarded. Such grave errors have been made occasionally, and a note of warning is not out of place. Only when laboratory findings are supplemented by clinical findings are a correct diagnosis and prognosis possible.—*James L. Zemsky, 147 Fourth Ave., New York City.*

Determining of Coagulation Time—There are several simple methods which may be effectively employed in testing the blood for coagulation time. Following is a simple and effective procedure, consisting in placing on a microscopic glass slide a drop of normal blood obtained by puncturing either the end of a finger or the lobe of the ear and beside it placing a drop of the blood to be tested. It is important that the blood should flow from the wound without pressure from the surrounding tissues because such pressure markedly diminishes the clotting time. At half-minute intervals, the point of a clean needle is inserted in the edge of the drop and then withdrawn. This should be repeated until a distinct string of fibrin can be seen to adhere to the needle, which occurs just a little before the clot is formed.—*James L. Zemsky, 147 Fourth Ave., New York City.*

ANNOUNCEMENTS

ANNOUNCEMENTS must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

CALENDAR OF MEETINGS

American Dental Association, St. Louis, Mo., October 24-28, 1938.

American Society for the Advancement of General Anesthesia in Dentistry, New York City, fourth Monday in March and October.

District of Columbia at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June, inclusive.

Greater New York Dental Meeting, New York City, December 6-10.

National Dental Association, Washington, D. C., August 10-13.

Australian Dental Congress, Sydney, August 16-20.

International Dental Federation, Stockholm, Sweden, August 9-14.

International Association for Research on Paradontosis, Copenhagen, Denmark, August 16-19.

American Dental Society of Europe, Paris, France, August 2-5.

Northern Illinois Dental Society, La Salle, September 29-30.

Montreal (Canada) Dental Club Fall Clinic, September 22-24.

STATE SOCIETIES

September

Southern California, at Los Angeles (13-15)

November

Florida, at Hollywood (4-6)
Ohio, at Columbus (8-10)
Puerto Rico, at San Juan

December

Hawaii, at Honolulu

STATE BOARDS OF DENTAL EXAMINERS

Arizona, September 6. R. A. McCall, 719 Professional Bldg., Phoenix, Secretary.

New Jersey, December 6-11. Walter A. Wilson, 148 W. State St., Trenton, Secretary.

ARIZONA STATE DENTAL BOARD

The next examination of applicants to practise dentistry in the State of Arizona will be held in Phoenix, beginning September 6. Applications must be filed at least fifteen days before the date fixed for the examination. Address all communications to

R. A. MCCALL, *Secretary*,
719 Professional Bldg.,
Phoenix.

NATIONAL DENTAL ASSOCIATION

The twenty-fourth annual meeting of the National Dental Association, formerly the Interstate, will be held at the College of Dentistry, Howard University, Washington, D. C., August 10 to 13.

J. A. JACKSON, *Secretary-Treasurer*,
Charlottesville, Va.

NORTHERN ILLINOIS DENTAL SOCIETY

The annual meeting of the Northern Illinois Dental Society will be held in La Salle, September 29 and 30.

HUGH E. BLACK, *Chairman*,
Program Committee,
La Salle, Ill.

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1937-1938

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